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From Rev. M. Hopkins, M. D., D. D., the distinguished Pres. of Williams College.

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DEAR SIR,—It would give me pleasure to see your works on Physiology widely circulated. It belongs to physicians to understand disease and its laws, but every man

ought to have, such a knowledge of his own frame, as to be able to understand, and apply intelligently, the laws of health. This would greatly tend to preserve health where it exists, and to prevent quackery in sickness; and such knowledge, I think, your book well calculated to promote.

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"DEAR SIR,—Your book, entitled "Popular Anatomy and Physiology," I have examined with some care, and have read sufficient to enable me to form a judgment of its design and execution. The book seems to me well adapted to the accomplishment of the object for which it is designed; to be well written, and free from any of those objections which delicacy might present to the study of a work on anatomy.

"I am with respect, your friend and servant,

"J. C. WARREN."

The following is an extract from a long notice of the work in the Boston Medical Surgical Journal:

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From Rev. W. H. Tyler, A. M., and Lady, the well known Principals of one of the best institutions in the United States. For several years, during some weeks each summer, Dr. L. has been in the habit of lecturing to the young ladies under their care, and they are therefore able to judge of the effect of his ideas, when carried out. In the last year's report of that Institution, it is mentioned as remarkable, that, "for the entire year, in a family numbering more than two hundred young ladies, the physician's bill was not fifteen dollars." It surely shows a rare state of good health, and that young ladies will be benefited by physiology when properly taught.

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Yours sincerely,
W. H. TYLER,
E. C. TYLER,
Principals.

Dr. T. S. Lambert.

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THOS. M. CANN."

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"LA FAYETTE COLLEGE.

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JAMES H. COFFIN."

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"LAMBERT'S SECOND BOOK.—*Practical Anatomy, Physiology and Pathology; Hygiene and Therapeutics.* By T. S. LAMBERT, M. D. New-York, October, 1850. —We have just been furnished with the above work, published by Leavitt & Co., New-York. It has been prepared from the Author's larger work, and expressly adapted to schools; and we notice that notwithstanding its long, and, to the general reader, somewhat formidable title, that its divisions of the subject and the definition of its professional terms are of the simplest and most intelligent sort. Its classification of the parts of the human body is based upon a natural division of their uses palpable to the common mind, and possesses a clearness, force, and unity of arrangement that cannot but fix in the mind of the student a distinct and indelible picture of the subject treated. Its phraseology has evidently been studied with care, and rather invites than otherwise the practical examination of the student. In both of the above particulars, this book presents a striking contrast to those upon the same subjects now in use in the schools. In the earlier part of the work, questions have been adapted to the text, and all simplified to the capacity of the child; and throughout the subject matter is explained by reference to simple facts in the knowledge of all. It is illustrated with colored plates, and a numerous set of wood engravings.

"And not least in a school book, the work presents a handsome binding, and a neat typographical appearance, which do credit to the publishers. We can hardly conceive how a work of such artistic merit can be furnished at the published price, and rather believe this a mistake. Physiology, as a study, has been already extensively introduced into the common schools; from our experience as a teacher, we are free to say under great disadvantages from the want of a proper text-book. This difficulty is now removed, and we feel confident that no parent or teacher who becomes acquainted with this work will use any other."

From Prof. Burnham, a Teacher of experience, Principal of the English Department in the well-known Burr Seminary, and also Superintendent of Public Schools.

"MANCHESTER, BURR SEMINARY, October 30, 1860.

"DR. LAMBERT:

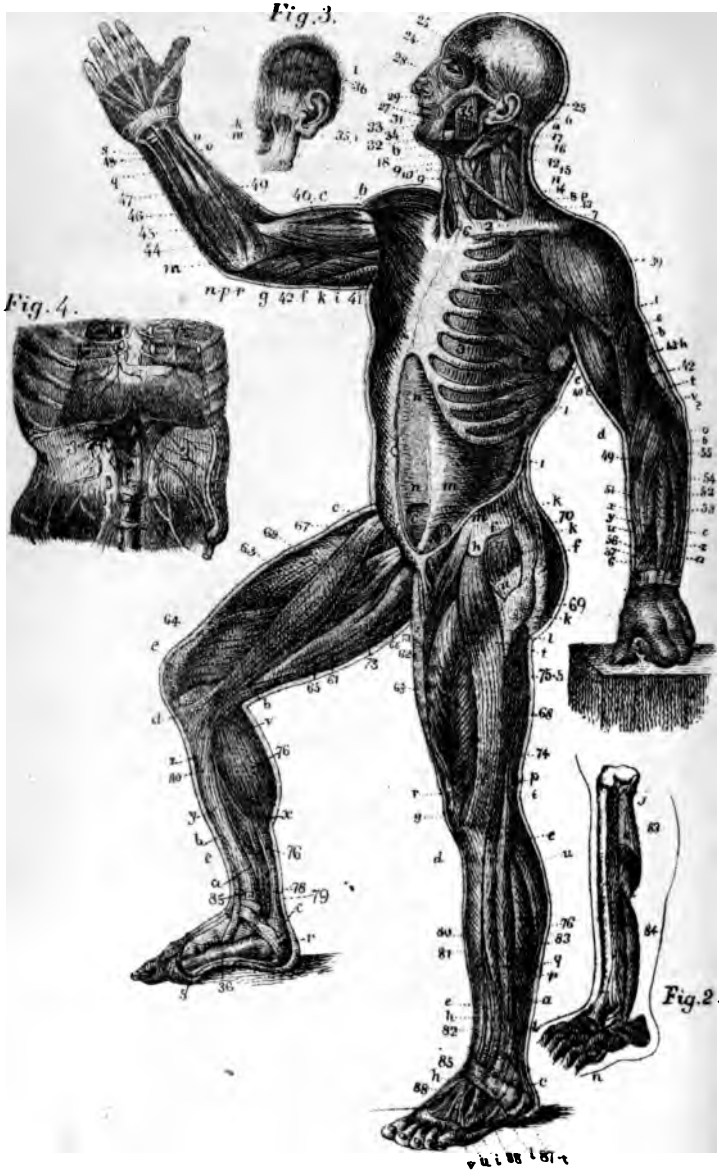
"DEAR SIR,—I have attentively and for practical purposes examined your books on Physiology, more particularly the Second Book, which I consider *better than any* with which I am acquainted, to be used as a school book, on the subjects of which it treats. The intelligent and faithful teacher cannot fail to make it an interesting and valuable branch of study. *Many excellences* might be named; I will specify but one, as rare: the discriminating language in which the questions are put to the pupil. I should be pleased to have this book introduced into the schools of this town, and to hear that its use was general. I think, also, that your book will be found exceedingly interesting to the general reader, and be used with great advantage as a reference book.

"Yours truly,

"W. A. BURNHAM."

Pl. 1.

Fig. 1.



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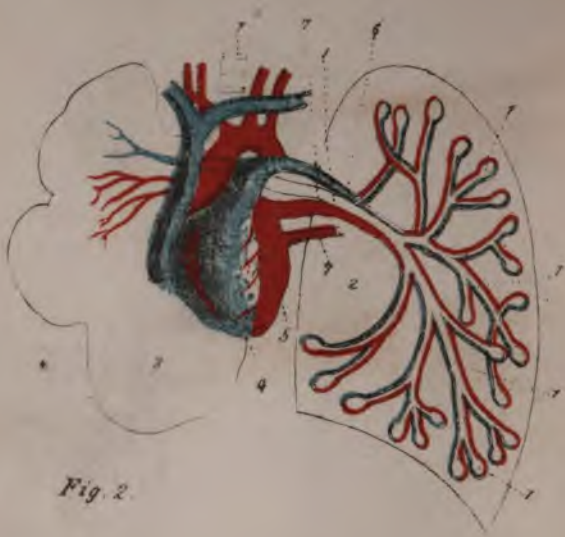

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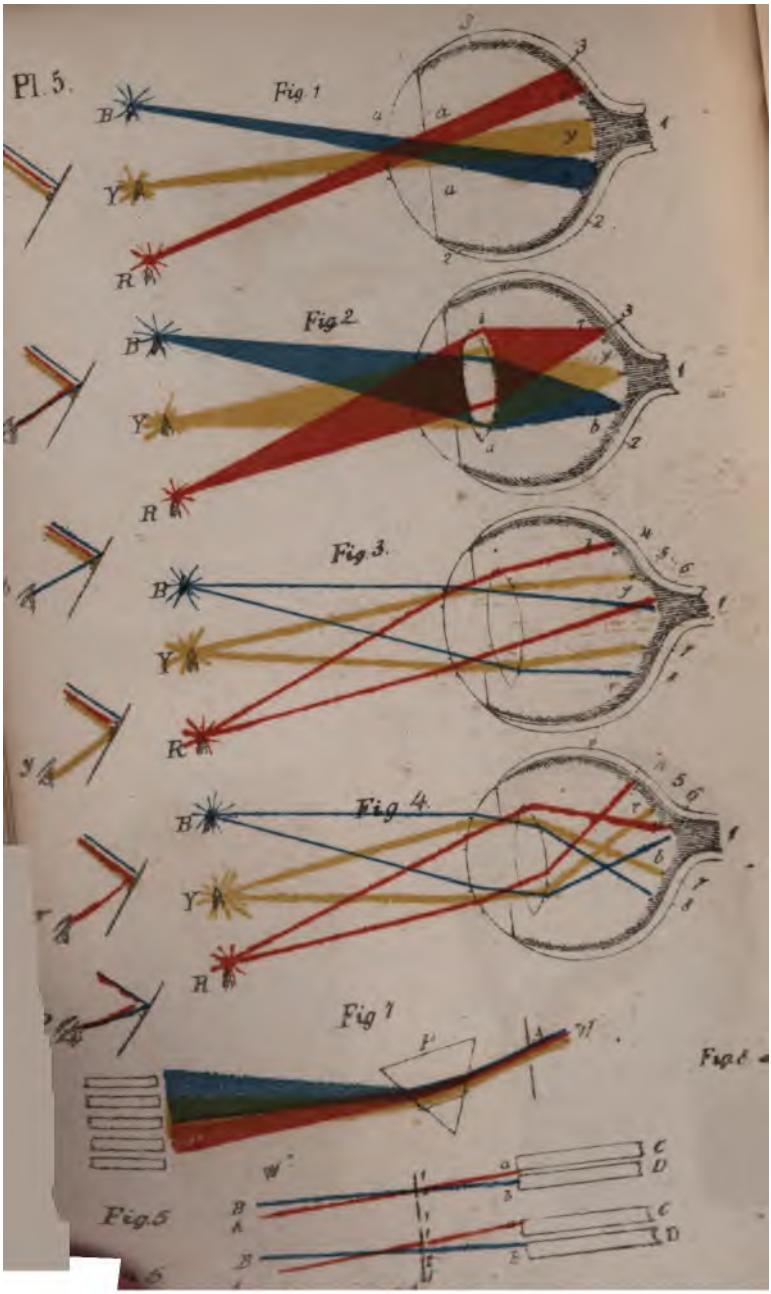

HYGIENIC

PHYSIOLOGY.

BY

T. S. LAMBERT, [illegible]

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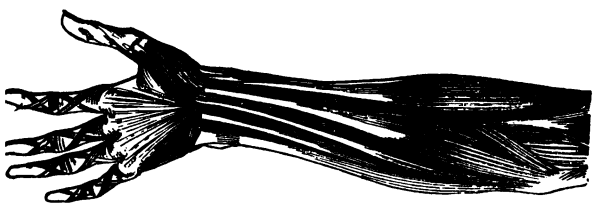

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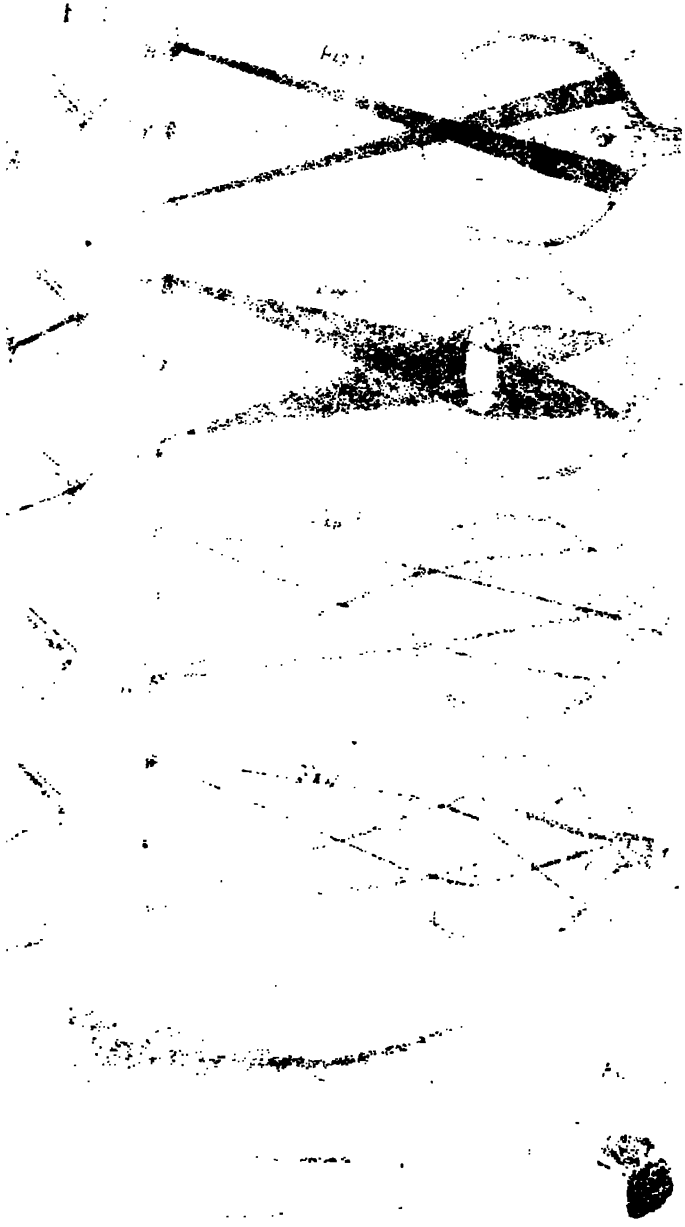

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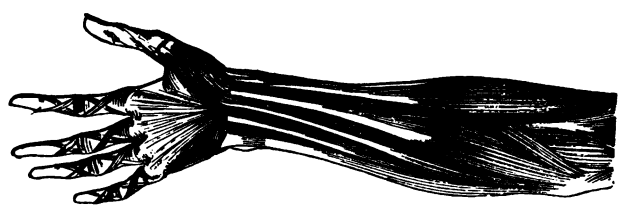

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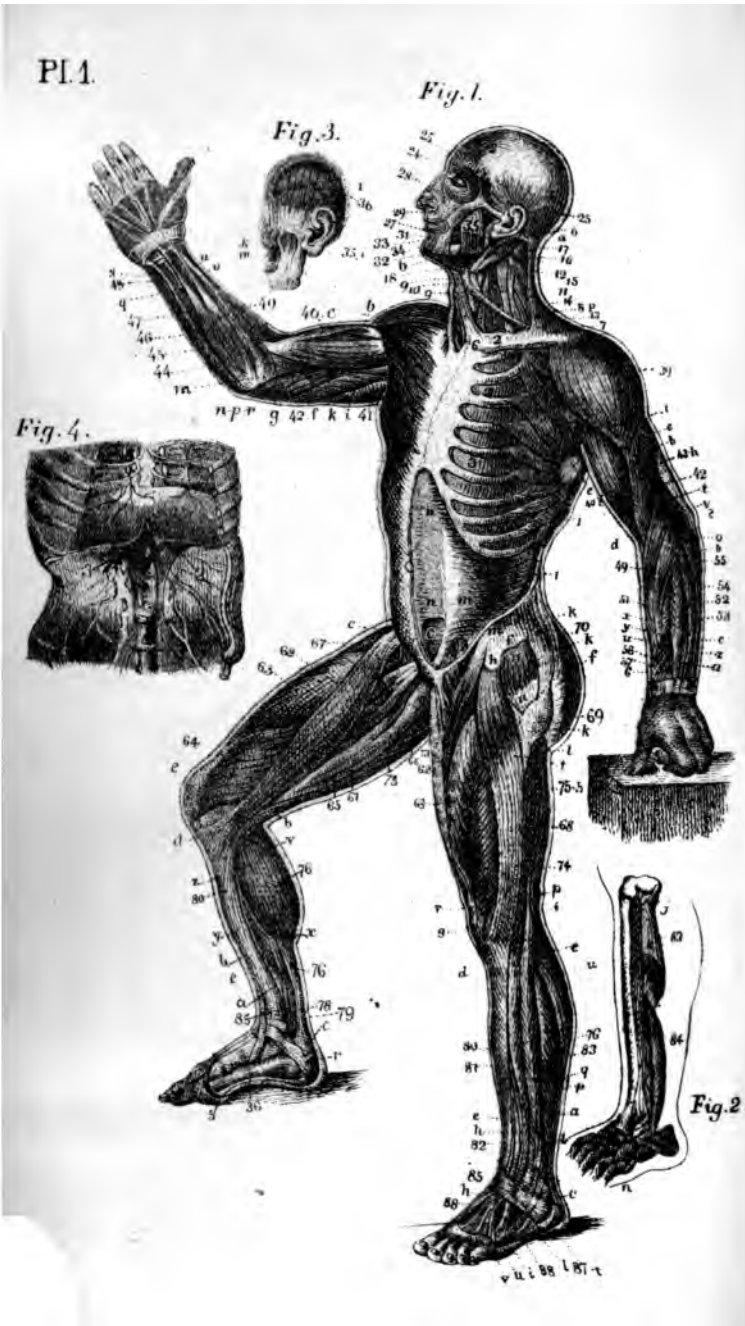

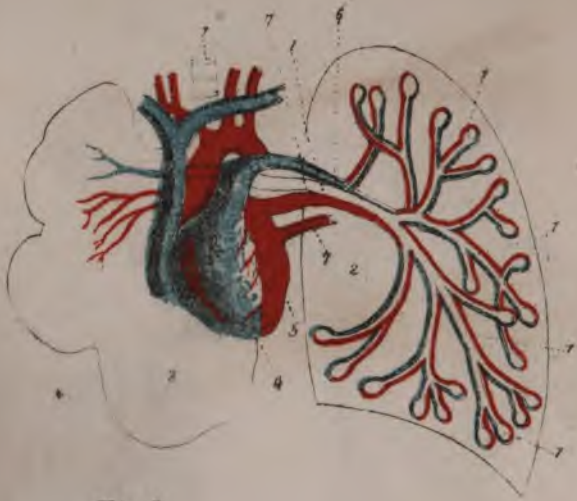

Fig. 2.

Fig 3.

vessels upon the sides of the air-cells. It is not so extensive as would in fact cover the sides of a mustard seed. The blood passes in through one set of vessels and passes back through another, as the colors exhibit.

Pl. 5, Fig. 1.—B, Candle giving off blue light. Y, Candle giving yellow light. R, Candle giving red light. In all cases the light passes from a candle in all directions, but only so many rays as would enter the opening a, are represented. Such rays passing through the opening a, fall upon the very much magnified commencing points of the nerve 1. The light from no two candles is seen to act on any of the same nerves. 2, Outer coats of the eye. 3, Pigmentum nigrum. Neither this nor any of the succeeding figures are intended to convey any correct idea of the eye, except as it respects the action of light thrown upon the nerves.

Fig. 2.—The light is seen passing through a lens, by the action of which, the entire yellow light passing through the pupil a, is made to act on one point; the same is also true of the light from R and B.

Fig. 3.—R, Y, B, As heretofore. But in this case the lens has not acted upon the light sufficiently to cause it to act on a single nerve, but the red light acts over the nerves between 4 and 6, the yellow light acts on the nerves between 5 and 7, and the blue light on the nerves between 6 and 8. The nerves between 4 and 5, and between 7 and 8, are acted on by one kind of light only, the nerves between 5 and 6 by both red and yellow (orange), and the nerves between 6 and 7 by blue and yellow (green). This is the case with long-sighted people. Most old people have indistinct vision from this effect being produced by the insufficient action of the parts through which light passes to the nerve.

Fig. 4.—R, Y, B, As before. In this case the light is acted upon so powerfully that it is bent to points or foci before it reaches the nerve; it passess the point or focus therefore, and when it reaches the nerves, the red light acts over the space between 4 and 6, the yellow light upon the nerves between 5 and 7, the blue light on the nerves between 6 and 8, and the same cause of confusion exists as in case of Fig. 3; that it is so, is evident by bringing a thing so near to, and removing it so far from the eye, that it becomes indistinct; the sensation is similar in each case. So also when the focus of a microscope or telescope is brought toward or removed from the eye, the effect is similarly indistinct. This is the near-sighted eye.

Fig. 5.—A, B, Are two rays of different colored light passing through the hole 2, in partition 1, 1, and acting on the end of one nerve D, producing the effect of compound light.

Fig. 6.—A, B, Two rays of different colored light acting on two nerves, a simple effect being produced on each nerve.

Fig. 7.—W, a ray of white light passing through the pin-hole a, and bent upward as it is passing through the prism P. The blue light is bent the most, the yellow more than the red but not as much as the blue, while the red is bent, but less than the yellow and blue.

Fig. 8.—The three colors which compose white light upon a small card. If it be whirled rapidly on a pin thrust through the centre, the light from each part will act on the same nerves, and the card will appear white.

Fig. 9.—A mirror reflecting all kinds of light.

Fig. 10.—A black object not reflecting any light.

Fig. 11, reflecting only red. Fig. 12, reflecting only yellow. Fig. 13, only blue.

HYGIENIC

PHYSIOLOGY

BY

T. S. LAMBERT, M.D.

PORTLAND, ME.
SANBORN AND CARTER.
1851.

studies in school?" Perhaps so. But if physiology be well understood, every other study will be taught more easily, acquired more quickly and thoroughly, and remembered more perfectly. It causes therefore no loss, but a saving of time; no crowding of teacher or scholar, but gives relief to both. If these expressions be thought extravagant, let the pages of even this little book testify.

"Will not knowledge of this kind injure by making a person nervous and imagine himself sick?" "A little knowledge is a dangerous thing." This wonderful scrap of wisdom is perfectly answered by those equal authorities: "Half a loaf is better than no bread." "Tall oaks from little acorns grow." The converse is true. Quackery fattens itself upon the ignorant. Not knowing better they are harassed by groundless anxieties and alarms, and readily believe the most barefaced falsehoods. To be sure, seemingly and self-called intelligent people sometimes lend too ready an ear to imposture, and give it currency by their authority; but we and they forget, that though intelligent, and therefore modest in respect to other subjects, yet ignorant of physiology, they are very easily deceived; and slightly actuated by self-conceit, they fail to use their ordinary common sense.

"Is it not impossible for children to understand physiology?" Decidedly, no! The answer is given after very great experience in teaching it in all grades of schools—in academies, colleges, and seminaries. Indeed, as of all studies it is the most useful and necessary to all, so when properly arranged and treated, there is no one so attractive to the older or younger scholar, or mastered with so little difficulty.

"Can this subject be taught by any teacher, and can any valuable amount of knowledge be obtained during a short school?"

An attempt has been made to adapt the following pages to this

very purpose. The price of course is such that every parent can test the value of physiology without noticeable expense. The time necessary can in any school be appropriated without objection. It is believed a great amount of useful matter has been given in a limited space, and in a manner interesting and intelligible to any child. A slight degree of pride is felt in the plan and arrangement, if not in the execution, and it is believed they will meet with a high degree of approbation. When the child is through the book he will have in his mind a whole, easy to remember from the mutual dependence of each part and the consecutive manner in which each step has been taken, and on account of the reasons and every-day life illustrations which have been exhibited. He will thus at least have a nucleus, to which, from his own observations or by farther study he can, and it is believed will, add something. The questions have been so prepared that any teacher or parent can, it is thought, do ample justice to the child by causing him to acquire his lesson thoroughly, and answer each question intelligently.

Suggestions to Teachers.

Many think that the most interesting and profitable mode of teaching and learning physiology is, to place the book in the hands of as large a class as can be formed, which shall read from it, once per day, or once per week, before the whole school, to which questions may be put at the same or the next reading. The subject is of such vital importance to every scholar, and to the family of every scholar, that a teacher can thus exert a very powerful,

useful, and extensive influence,—an influence of inestimable value towards correcting a host of evils that exist in society. The powerful influence that a correct view of physiological principles will exert, will also, it is believed, not only cause the scholars to be more easily governed, but to increased docility it will cause them to add a laudable enthusiasm in all their pursuits; and their delight will be to please their instructor, their parents, and their mates. Thus will he find true one of the strong points of physiology, viz.: that whatever we do to add to the happiness of others, will surely add to our own. If the lessons be committed and recited, it is of especial importance in this subject that they be short, perfectly acquired, and often reviewed. If time permit, the readings or recitations can be made much more interesting and valuable by experiments and illustrations, drawn from observation or from other books. Much of interest to the youngest pupil may be found in the larger works of this series. However this book may be used, it is hoped it will prove an assistance to the teacher, delightful to the scholar, and profitable to the parents.

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HOW THE BODY IS KEPT WARM.

BOOK II.

THE COOLING PROCESS.

ADDENDA TO PART II.

PART III.

APPENDIX.

ACCIDENTS, POISONS, QUACK MEDICINES, ETC.

INTRODUCTION.

"When Powers, the celebrated sculptor, was three or four years old, he was one day playing on the hearth before the fire. Suddenly turning towards his mother, he inquiringly exclaimed,—What becomes of people when they are dead? They are buried, was the mother's reply. No, that is not it, said he, I want to know what becomes of the *think* part."—*Anecdote told the author by a relative of Powers.*

Suppose in summer a barefooted boy is running across the fields looking at his kite, high in the air above him. All at once a thorn pierces his foot: he suddenly stops, turns his foot upon its side, bends down his head, and directs his eyes towards the injured foot; he quickly learns that the thorn is there still, and now begins to bend his back. He raises his foot and leg, towards which he moves his hand. He seizes the thorn with his fingers, draws his arm back, and the thorn is pulled out. He now replaces his foot on the ground, straightens himself up, lifts his eyes towards his kite as it flies higher and higher, and looks down on those of all the other boys. With what joyful exultation his merry voice rings through the air!

1. *Three things are here evident.* 1st, the boy feels the pain caused by the thorn; 2d, he thinks how he shall extract it; 3d, he causes the action necessary for that purpose,—in brief, he feels, he thinks, he acts.

[It is not the boy's foot that feels, for though the pain seems to be in the foot (we shall soon see why), if it be removed from the body, a thorn

---

What is said of Powers? Did you ever prick your finger? How did you know? What did you do next? What is the supposition made? ¶ 1. What four things are evident? In brief, what is said? What does not feel? How do we know? How do

can be thrust through it without causing pain. Neither can it be the foot which thinks; because when the foot is removed, the boy can think as well as before. Nor can it be the foot which causes the moving of the head, eyes, or arm, for all these can be done when the foot is cut off.

In various like ways it can be proved that no part of the body is that which feels, thinks, or causes voluntary action, but that,]

2. *The various parts of the body are* only means with which to feel, think, and act.

3. *The mind is* the name of that which feels, thinks, and acts.

[The overseer in a factory or hotel, occupies a place called an office, where reports are made to him. Thus, he learns the state of things in all parts of the building of which he has charge, and how matters out of doors, pertaining to his business, are going on. He thinks these things over, and in various ways, makes his calculations, and then issues his commands, and brings about, so far as he can, what he judges is for the best of the whole concern. So we shall find it will be very appropriate for the mind to have some office to which reports from all parts of the body shall be made; where it does its thinking, and from which commands shall be issued to all parts of the system.

Suppose in a hotel, proper reports shall not be made. Or suppose the overseer does not think the matter over correctly, or that his commands are not faithfully obeyed. In either case, something must go wrong. So if the mind do not receive correct reports, think correctly, or do not have its orders correctly and properly attended to, things will not go as they should.]

Inf.—We desire, therefore, to learn how to keep the various parts of the body in such a condition that the mind can feel, think, and cause action most perfectly.

[For when a person is in such a condition that he feels, thinks, and acts in the most perfect manner, he is enjoying and in every respect taking advantage to the highest possible degree of the world which is within and around him.]

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we know the foot does not think? Why does not the foot cause action? What part of the body feels? ¶ 2. What are various parts of the body? *Are all parts used to think with?* ¶ 3. What is the mind? What is said of an overseer? Did you ever visit a large hotel or factory? What does appropriate mean? What should the mind have? If the mind does not receive correct reports, what is the result? What ought we to desire to learn? When does a person enjoy the most?

PART I.

THE MEANS BY WHICH THE MIND FEELS, THINKS, AND ACTS.

BOOK I.

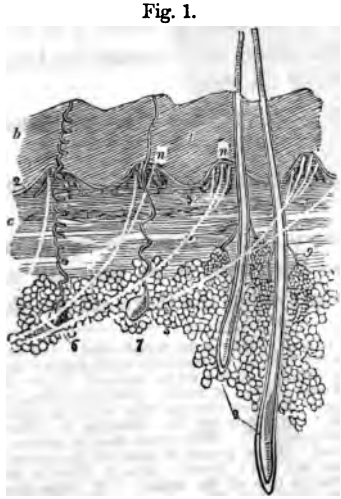
THE MEANS BY WHICH THE MIND FEELS.

CHAPTER I.

Organs of the Sensation of Temperature and Touch—The Skin, Nerves, and Brain.

[Every boy knows that a pin may be thrust through the outer surface of the skin, without causing pain. If the prick be a little deeper, pain is felt at once. The outer part of the skin is not, therefore, but the under part is, concerned in the process of feeling.]

Fig. 1.



By some, the skin is divided into two, by others into three, layers. The outer layer is the same in both cases. It is the white part which is raised in case of a blister, and is called cuticle, scarf-skin, epidermis, &c. It is represented at *b*, fig. 1. Its use is to protect the parts below, and is, therefore, as it should be, thick over some, and thin over other, parts.

Illustration.—The calloused hand of the laborer, and the delicate hand of a lady.

The outer portion, **2**, fig. 1, of the remaining parts of the skin, is by some called the rete mucosum (mucous network); the still deeper part is called dermis, cutis, true skin, &c., *c*, fig. 1. Near the outer surface of this last, and composing it in part, are found the commencing points of

The Nerves.—These are white, soft cords, exceedingly small when they commence—so small as not to be seen with the naked eye—and it is yet impossible to tell how they do commence precisely, though by fig. 1, *n*, they are represented as coming from points. If we should attempt to trace one from the skin, we should quickly find it meeting another, with which it

joins company—another and another being added, a bundle as large as a hair is formed. This soon meets other bundles, and as they all have the same destination, they so unite as to form a larger bundle; all these bundles, as well as the fibres that compose them, being called nerves. If these bundles be traced, we find those from all parts below the neck passing through holes in each side of the back, into a canal which exists through the whole length of the back-bone.

Illus.—Look at the back-bone of any animal when killed, or look at a piece of cooked meat containing a portion of the back-bone.

The spinal cord, *a*, fig. 2, is the name of that which to a great degree is formed by the nerves in the canal of the back. It can be traced up through a hole in the skull to the brain. In one respect, therefore, it may be considered as a great nerve. Some of the nerves from the head and face enter the skull through small holes in the bottom and sides of it. These nerves also connect with the lower part of the brain. THE BRAIN is a part of the body found in the skull, *b*, fig. 2. It is about three-fourths the size of the outside of the head, composed of many parts of various colors, forms, &c. Of it more will be said bye-and-bye.

4. *The reason why the boy feels*, is, in the first place, because the nerve is pricked. Proof: If he do not prick deeply enough to touch a nerve, he does not feel any pain. The instant he touches a nerve, he does feel pain; and again, if the nerve be cut across any where, for instance at *s*, fig. 2, between the thorn and the brain, he will no longer feel pain.

Illus.—If a bell-wire be broken between any room in a hotel and the office, the occupant of the room may pull his bell-cord, but it produces no effect at the office.

5. *The use of the nerves of the sense of touch*, is to connect between the skin and the brain, and to cause the brain to be acted upon by the state of the skin.

[If a person be stunned, he will not feel the effect of any thing which injures him.]

6. *The brain must be in a proper condition*, or the boy cannot feel.

7. *Five things are necessary*, in the supposed case, that the boy may feel. 1st. The thorn (which we may call an object). 2d. The skin, through which the thorn acts on the

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What does every boy know? What follows? How is the skin divided? Did you ever notice the outer layer? What is its use? Where should it be thick, and is it so? *Illus.*? What is *b*, fig. 1? What is the dermis? What are the nerves? Where do they commence? Describe how they would appear, if traced. Give your idea, by drawing some of them on the blackboard. Did you ever see what is in the back-bone of an animal? How did it look? Did you feel it? Describe it. What is it called? What is it in part composed of? With what does it connect? In one respect, what may it be considered? What is said of some of the nerves? What is the brain? ¶ 4. Why does the boy feel? Proof? *Illus.*? What is the use of the nerve of touch? ¶ 6. What is true of the brain? ¶ 7. What five things are necessary that the boy may feel? ¶ 8. Why should the sensation be

Fig. 2.

nerve (in this respect the skin is called an organ of sense). 3d. A nerve (the effect produced in or upon the nerve is called an impression). 4th. The brain. 5th. The mind (the effect produced on the mind by the brain, is called a sensation, or feeling).

8. *The reason why the feeling produced by the thorn should be painful or unpleasant*, is, to call the attention of the boy to his foot, and compel him to take care of it.

Inf.—If by taking opium or doing any thing, the boy could so act on his nerves or brain, that through them the thorn could not produce any effect on his mind, he would be doing himself a great harm, for at every step the thorn would sink deeper and deeper into his flesh.

[Persons do, however, frequently by the use of tea, coffee, tobacco, and alcoholics, so act on their brains or nerves, that they can no longer feel fatigue or other distress caused by overeating or the like, and think they have done themselves a service, because they no longer feel unpleasant sensations; while, if they would ask themselves if the cause which was injuring them were removed, and which ought to distress them, they would see that their apparent friends are their worst enemies.

But when the overseer in a hotel hears a bell ring, he desires not merely to know that somebody in the house needs attention, but in what particular room it is required. So when the boy feels pain, it is requisite that he know what particular part of the body is injured.]

9. *A person knows what particular part of the skin is injured*, because he is so made, that his mind believes when a sensation is produced through any particular nerve, that the cause of the sensation is acting at the part where the nerve commences.

Illus.—If a sensation be produced through the nerves commencing in the hand, the mind believes the cause of it is acting on the hand, and on that particular part of the hand where the nerve commences.

Inf.—It will make no difference whether the cause do act on the hand or on the nerve somewhere between the hand and brain, or if

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painful? What is the *Inf.*? What do persons frequently? When a bell rings, what does an overseer desire to know? ¶ 9. How does a person know what particular part is injured? *Illus.*? *Inf.*? *Illus. a*? *Illus. b*? *Illus. c*? *Illus. d*?

disease exist somewhere in the course of the nerve, provided through the nerve a sensation is produced, it will seem to be where the nerve commences.

Illus. a.—If somewhere between a room and the hotel office, a bell-wire should be pulled, the overseer would believe that the cause was acting in the room where the wire commenced.

Illus. b.—If a person strike the corner of the elbow, it will seem to him his little finger is affected, because he injures the nerve *u*, fig. 2, which commences in the little finger.

Illus. c.—When a person's "foot is asleep," it is usually because a large nerve, the branches of which commence in the foot, has been compressed at *s*, fig. 2, between the lower part of the hip bone, and the seat on which he has been unpleasantly seated.

Illus. d.—When a person has had a limb removed, even for a score of years or more, he will have sensations caused through the nerves that extend from the stump *l*, fig. 2, to the brain. As these nerves naturally commenced in the hand and lower part of the arm, it will seem to the mind, as if such sensations were produced in the hand and arm, which will therefore seem to him to be yet present.

Inf.—The pain must therefore be in the mind, though it seems to be in the part where the nerves commence, through which it was caused.

[It sometimes is the case, that sensations are felt and seem to the mind to be in a part which is not injured or diseased, and when the nerves extending between it and the brain, are not, so far as we can judge, badly affected by any cause. Why this is so, we do not know. It sometimes also happens that a sensation is produced when the cause of it does not seem to the mind to be acting on any particular part.]

Inf.—Taking all these things into consideration, it will sometimes be very unsafe to judge of the location and extent of injury from the pain felt, and much skill will sometimes be required to comprehend the nature of the cause producing the trouble complained of.

[When the overseer in the hotel, has learned that some attention is needed in room A, he does not know what that attention is, till he has made further investigation. So when the boy learns what particular part of his foot requires attention, he does not know what that attention is until he calls in the aid of his eyes. Before, however, we consider those organs, we will notice the various kinds of sensation produced through the skin, and the knowledge thereby gained by the mind.]

10. *The skin is called the organ of the sense of touch,*

Inf.? Can we always judge where the cause of a sensation acts? Why not? *Inf.*? ¶ 10. Why is the skin called the organ of the sense of touch? *Inf.*? ¶ 11. Why is

because when any thing is merely brought in contact with it an effect is produced by which we know the presence of an object.

Inf.—As the mere contact of an article with the skin is neither harmful nor beneficial, there should be neither a painful nor pleasurable sensation produced. So it is.

11. *The skin is called the organ of the sense of temperature*, because through it, objects, by their temperature, produce effects on the nerves commencing in the skin.

Inf.—Since too high or too low a temperature is prejudicial to health, either extreme ought to produce, as it does, unpleasant sensations; while a healthful temperature ought to produce agreeable sensations, as is the case.

Illus.—If a person recline on a pleasant summer's afternoon, beneath a shade-tree, how delicious the sensations! The skin seems to drink in delight at every pore.

[Through some parts of the skin sensations, such as of tickling, may be in some persons caused.]

Inf.—This fact shows that all the nerves extending from the different parts of the skin to the brain are not alike.

12. *Through the nerves extending from the skin to the brain* we gain a knowledge of the injuries done to, or of disease existing in the skin. Sensations thus caused should be, and are painful.

13. *The art of pleasing the mind through the skin consists* in preserving it free from disease and injury, and especially in acting on it by healthful temperatures.

[Cold hands and feet will not only produce direct discomfort, but also tend to produce an unpleasant disposition.]

Illus.—Who would think of asking a favor of a person when cold and uncomfortable?

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the skin called the organ of the sense of temperature? *Inf.*? *Illus.*? What fact is stated? Is it so? Can all persons be alike tickled? What part is very easily tickled? How do you account for these differences? ¶ 12. If you burn the skin, do you know it? How? Of what do you gain a knowledge, by the nerves extending from the skin? ¶ 13. What is the art of pleasing the mind, through the skin? What of cold hands,

CHAPTER II.

Organs of the Sensation of Sight—The Eye, Nerves, Brain.

[When the eye is directed towards the foot, the boy at once sees the thorn; but the thorn is some distance from the eye. There must, therefore, be something which acts between the thorn and the eye. This something is called Light. But the thorn does not look like the foot—nevertheless, that which acts between the foot and eye, is also called Light. The truth is,]

14. *Light is* of several different kinds, viz. Three.

[Different kinds from those which act upon the thorn, come from the foot, and consequently the foot and thorn do not look alike.

But in order that the boy may be able to extract the thorn, he must know in what direction it is from his hand, &c. How he is to know this, we shall see.]

15. *Light acts* in straight lines, till by some means it is bent.

Illus.—If a person place his finger in a line, between his eye and a burning candle, the light of the candle will no longer act on his eye.

Inf.—As two different objects must be in two different directions from the eye, light acting from the objects must act in different directions.

Illus.—Light coming from the red candle, in fig. 2, Pl. 3, does not act on the eye from the same direction as the light from the blue candle.*

16. *A great part of the light which enters the eye*, is bent at once in such a way that when the eye is healthy, all the

* It is frequently supposed in philosophy, that light coming from different objects acts upon the eye in parallel lines. This is never the case, and ought never to be supposed, for the whole process of seeing depends on the light from different objects acting upon the eye from different directions.

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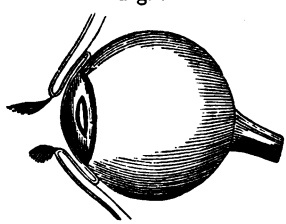
etc.? Does any thing act between the thorn and the boy's eye? How do you know? What is it called? ¶ 14. How many kinds of light are there? Why do not the foot and thorn look alike? If the same kinds should come from both the thorn and the foot, could he readily distinguish between them? Can you easily distinguish a piece of white paper placed on a piece of white paper? Why not? ¶ 15. How does light act? *Inf.*? *Illus.*? ¶ 16. How is the light bent, when entering the eye? ¶ 17. That

light entering the eye from an object, is brought to a point called a focus.

[As the light from different objects is bent on the same principles, it follows, as is seen in fig. 2, Pl. 3, that as the light from different objects enters the eye from different directions, so it will be bent to different points, or foci.]

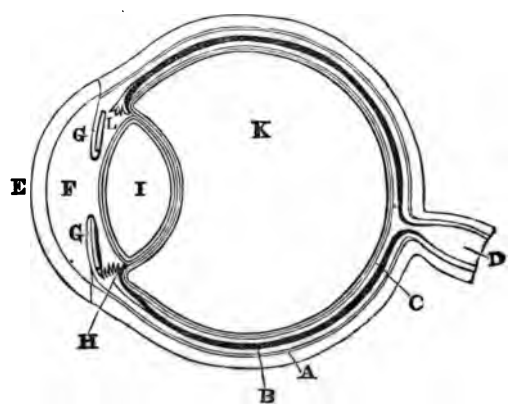
17. *In order that the light may enter the eye, and be bent to a point*, it is necessary that the parts forming the front part and inside of the eye, be transparent, like glass, have a certain form, and be of a certain and proper consistence.

Fig. 3.



The Eye.—The white of the eye (from its hardness called the sclerotic coat) is a protection box, with a large opening in front, and a smaller one behind. The opening in front is closed by a kind of window, called the cornea, wrought of the most beautiful material, and as pellucid as the clearest crystal. It is fitted into the opening of the white coat, much as the crystal of a watch in its case. Within this window (which is about as thick as the finger-nail), a watery fluid (aqueous humor) fills what is called the anterior (front) chamber of the eye. (F, fig. 4.) It is that part

Fig. 4.



the light be bent, what is necessary? Can you look in at the front part of the eye?

in front of the colored portion of the eye, G G. This latter is called the iris (rainbow). A hole through it is called the pupil, or the apple of the eye. Through this opening we can pass into the posterior (back) chamber of the eye, L, fig. 4. This is also filled with the same watery fluid. Passing quickly through this chamber, we reach a part of the eye called the crystalline (crystal-like) lens, *I*, fig. 4. Back of this, we find the remaining portion of the eye filled with a substance which much resembles the white of an egg, but is more transparent. This is called vitreous (glass-like) humor. It is these parts, taken together, which cause the light to be bent to foci. At the outside of two-thirds of the back part of the vitreous humor, what is usually termed the retina (net-work) is found. This seems to be composed of the commencing points of millions of nerves, too small, of course, to be distinguished by the naked eye, and, indeed, they are so small that it is difficult to say precisely how they commence. Fig. 5 conveys a partial idea of how the nerves may be supposed to commence. From the points where they commence they all converge, following the same course as the surface of the humor, till at last conjoined, they form a bundle, or large nerve, called the optic (to see with) nerve. This can be traced from the back part of the eye to certain parts of the lower and inner portions of the brain.

Fig. 5.

[The nerves commencing at the points where the foci of light coming from different objects are produced, it is evident they can be acted on by light coming from different objects. That seeing is thus in part produced, is proved by the fact that when, by any cause, the light is not so bent in the eye as to act in a proper way on the nerve, a person cannot see correctly. If the nerve should be cut across, or by disease unfitted for its duties, the person cannot see. When a person is stunned by a severe jar of the brain, he cannot feel the effect of light.]

18. *The use of having the light bent to a focus is*, that all the light that enters the eye from one object, may be caused to act on one nerve, and thereby through the nerve and brain produce a single sensation.

[For if the light from two different objects, as from A,B, fig. 5, Pl. 3, act on one nerve at the same time, there can be only one sensation produced, but if the light from two different objects A,B, fig. 6, act at the same time on two different nerves C,D, then the light from A,can produce one effect on the nerve C, and through it one sensation.*]

* An object, speaking in a strict sense in respect to seeing, is exceedingly small, yet

Describe the eye. Draw it on the blackboard. Describe fig. 5. What does the word foci mean? How can the nerves be acted on? How is seeing proved to be produced? If the nerve should be cut across, what? ¶ 18. The art of having the light bent?

19. *That the boy may see the thorn*, six things are necessary—1st. The thorn (which we will call the object). 2d. The light (which acts between the thorn and the boy's nerves). 3d. The eye (which bends the light, so that all the light entering the eye from any visual object shall act on some particular nerve: being the part through which the object, viz., the light in this case, acts on the nerve, it is called an organ of sense). 4th. The nerve (the effect produced by light on the nerve, is called an impression). 5th. The brain. 6th. The mind. The effect produced on the mind is called a sensation.

[In order that the boy may derive, through his eye, distinct and practical ideas in regard to the thorn, the light coming from it should produce an intense effect. Hence—]

20. *One reason why the light is bent* in the eye, is that all the light entering it from any visual object may act on one nerve.

[For if, as in fig. 3, Pl. 3, the light from any point be not bent to one nerve but act over several, the effect produced will be nothing like as great as if it should all act on one.]

Illus.—If we go into a room where there is but little light entering our eyes, we cannot see distinctly.

21. *Another reason why the light should be bent in the eye*,

it may be composed of what will appear through the eye to be several objects, when sufficiently separated, as in case of A B, fig. 5, appearing to be but one, and as if it were purple, while in fig. 6 they will appear to be two, one red and the other blue. That is to say, visually that is an object from which the light acts on a single nerve; it cannot therefore be inverted, because it is always through the eye, regarded merely in reference to itself. It is entirely different from such an object as an arrow, a pen, or a tree. These are, so to speak, mental objects, and composed of thousands of visual objects.

From not properly considering what is learned through the eye, much confusion in the use of language has arisen. Inverted images have been talked of, and also whether what was seen by a person, was the thing or the image, &c.

Describe fig. 5 and fig. 6, Pl. 3. Give the substance of the foot-note. ¶ 19. That the boy may see the thorn, what six things are necessary? If any of these should be wanting, what would be the result? ¶ 20. What reason for the light being bent in the

is that as different kinds of light will produce different effects on the nerves, and through them different sensations, therefore the light coming from different objects would, by acting on different nerves, enable a person to judge to a certain extent of the objects before him.

Illus.—One kind of light will produce a sensation of redness, and we call the object from which it comes, a red object. Another kind produces a sensation of yellowness, and we call the object from which it comes, yellow. Another kind produces a sensation of blueness. If yellow and red light act on a nerve at the same time, they produce a sensation of orange. If red and blue, a sensation of purple. If a proper proportion of all three kinds act at the same time on a nerve, a sensation of whiteness will be caused. If no light whatever act on the nerve, a sensation of blackness will be the result.

22. *A third reason why the light should be bent to a point*, is that a person may know from whence the light comes.

[For as the eye is constituted when correct, it is not possible for light to act on any nerve without having come from a certain direction.]

Illus.—In fig. 2, Pl. 3, the light from R must necessarily act on a nerve at the upper and back part of the eye, while the light from B must necessarily act on a nerve in the bottom and back part of the eye.

23. *We are so constituted* as to believe, therefore, that when the mind perceives a sensation produced through any nerve, the light which has caused it, has come from a certain direction, and that the visual object at which we look, is in that direction.

[Therefore when a light is bent toward our eye by a mirror, we think the object is in the direction of the mirror.]*

24. *Two evils in respect to the eye are frequently noticed*, long and short-sightedness.

* It is the light, of course, which causes the effect on our nerves. It makes no difference whether the light be bent or not, provided it be not altered in any other respect. The same effect will be produced in one case as in the other. If we look toward a mirror, we see the same thing as when we look toward the object itself.

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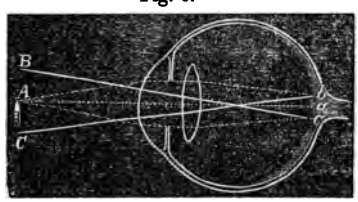
eye? What if it be not bent? ¶ 21. Another reason? *Illus.*? ¶ 22. A third reason? What is not possible? *Illus.*? ¶ 23. How are we constituted? What do we think, if we look toward a mirror? Foot-note? ¶ 24. What two evils noticed? When does

[The first exists when the eye is in such a state that the light is not sufficiently bent, as seen in fig. 2, Pl. 3. In this case, the light does not in the first place, act on any one nerve with sufficient intensity; the sight therefore is "dim." In the second place, as shown by the same figure, the light from different objects will act on the same nerves at the same time, and of course confusion would be produced. In the third place, the light from any point acting upon several nerves, and the mind receiving sensations through several nerves, the object would seem to be either very large or in several different directions, as shown by fig. 6.

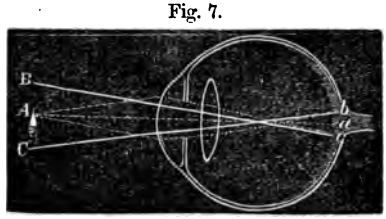
Fig. 6.



The light from the object A acts over the nerves between *b* and *c*, and on account of the sensations being received through the nerve *c*, the object will appear to be in the direction *c b*. Long-sightedness is sometimes remedied by habituating one's self to looking at near objects. Usually it occurs in old persons, who can only relieve the evil by wearing glasses. As we do not know the precise cause of it, we do not know very well how to prevent or cure it.

Short-sightedness exists when there is such a state of the eye (we cannot tell precisely what to term it) that the light is bent to a focus before it reaches the nerves. It then crosses and continues on in the same straight course till it does reach the nerve, as seen in fig. 4, Pl. 3. If in this fig. the action of the light upon the nerves be noticed, precisely the same results are produced as in the case of the long sight. This evil is usually produced by confining the eyes to near objects, and is to be remedied in many cases by looking or trying to look at distant objects. It can be prevented by being careful to read or hold the work at different distances, and by frequently looking at distant objects.

Fig. 7.



the first exist? What is the trouble, in the first place? Second place? Third place? Describe fig. 6? How sometimes remedied? When does short-sightedness exist?

25. *Pleasurable sensations are produced* through the eye, when a proper quantity of proper kinds of light act for a proper time on the eye.

26. *The proper kinds and proper proportions are* those which are shed upon the world by the sun.

[The kinds coming from the sun are three, red, yellow, and blue. The proportions we have not space to state, nor does it matter. If now, red, yellow, and blue, either or all of them, but in improper proportions to each other, act upon the nerves for any length of time, unpleasant sensations are produced.]

Inf.—The lights which we burn should produce light of the same character as the sun.

27. *The true way to please the mind through the eye*, is to have the colors of carpets, wall-paper, curtains, and various other articles of our furniture and dress, such as are in accordance with our natural constitution.

Illus. a.—How beautiful the rainbow and the violet.

Illus. b.—How elegant the effects of mazarine-blue and orange, or of purple and straw-color.

Inf.—Ladies by cultivating a proper taste, and studying the physiology of the eye, may render themselves and their homes more attractive, by combining tastefully, the various colors, in their dress and furniture. Flowers and plants are always beautiful and pleasing to the eye. Let us cultivate them in our gardens, and in neat pots within doors. Let us adorn our rooms with tasteful and well-chosen flowers. Let us have our school-rooms cheerful, and adorned with pleasing varieties of color, and with even beautiful flowers. We shall soon perceive the genial influence on youthful dispositions. Again, let us cultivate our tastes, that we may admire the ever changing pictures, those ever varying colors which the Creator has in his goodness so bountifully exhibited in the sky, in the ocean, and in every part of the earth. Let us thus add to our happiness, the only true wealth. The world is beautiful, and we ought to enjoy it, and if we will we can.

How usually caused? How remedied? Are some born near-sighted? ¶ 25. When are pleasurable sensations produced? ¶ 26. What are the proper kinds and proportions of light? What are they? *Inf.*? ¶ 27. How please the mind through the eye? *Illus. a*? *Illus. b*? *Inf.*? If you require the help of a distant person, how do you

CHAPTER III.

Organs of the Sensation of Hearing—The Ear, Nerves, Brain.

[Suppose the boy, to extract the thorn, should require the assistance of one of his companions, who is at a distance. How is he to draw attention when no one is looking toward him? We see him begin to move his lips, tongue, and throat. But as these cannot directly act on a distant boy, something more is necessary. Besides, if we place our forefinger near and in front of his lips, we shall feel that when he shouts the air is coming out of his mouth in jets. Now, as the air reaches all the way from the boy to his companion, when he throws the air out of his mouth the effect will reach all the way to his companion, if the distance be not too far, and an action will be produced on some part of his companion's body, and through it an effect will be produced on his mind. As the air is thrown out of the boy's mouth with different degrees of force, and in other different ways, so will different effects be produced on his companion, who will thus be informed of what the boy wishes. It is so with every thing which produces sound.]

Illus. a.—A ringing bell, shakes the air, or causes it to vibrate.

Illus. b.—A cannon fired shakes the air so forcibly that it will sometimes break the neighboring glass, and we can feel the effect through every part of the body.

Exp.—If a bell be shaken in a jar from which all the air has been pumped, no sound is produced, since there is no air for the bell to act upon.

[The smallest as well as the largest sounds are caused by vibrations of air. But when these are gentle, as when caused by a falling leaf, they do not act so strongly on the hand, that through it the mind can perceive any effect. Some part of the body must be particularly adapted to this purpose, and so delicately constructed that the slightest trembling of the air shall produce an effect through it. This part must be the ear, for when a boy or girl does not wish to hear any thing, we see the ears closed with both hands.]

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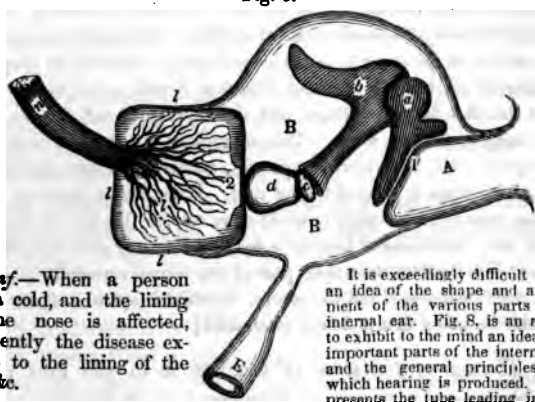
get it? What passes from the lips of the speaker to the hearer? *Illus. a?* *Illus. b?* *Exp.?* When vibrations of the air are very gentle, what is necessary? Describe the

THE EAR.—Every one knows the appearance of the outer ear, and that near the lower part there is a tube leading into the head. This tube extends only half an inch or an inch, when we come to its termination, by what is called the membrane of the Tympanum (drum or outer drum-head.) If we go through this we come to a space about the size and much the form of a kidney-bean, called the drum. From the lower part of this there is a trumpet-shaped tube leading down and opening into the upper and back part of the nostril, through which any thing of a fluid nature can pass down to, and air can pass up from the throat and nose. The same kind of lining as is found in the nose, lines the tube, the drum, and the mastoid cells.

Fig. 8.



Inf.—When a person has a cold, and the lining of the nose is affected, frequently the disease extends to the lining of the ear, &c.

It is exceedingly difficult to give an idea of the shape and arrangement of the various parts of the internal ear. Fig. 8, is an attempt to exhibit to the mind an idea of the important parts of the internal ear, and the general principles upon which hearing is produced. A, represents the tube leading into the ear. B, the drum. E, the Eustachian tube. Across the drum, from side to side, what is called a chain of bones is stretched: *a*, called malleus (hammer), is connected to the outer head, 1, of the drum; *b*, the incus (anvil), is joined to *a*, on the one side, and to *c*, the orbicularis (round) on the other; *d*, the stapes (stirrup), is joined to *c*, and also attached to one of the inner heads, 2, of the drum; If we pass through either of these we shall come into a part called the labyrinth, which, as its name signifies, is very intricate in its passages. Why it should be so, we do not know. In some animals it is a very simple apartment. It is chiefly filled with fluid called the aqueous (watery) humor of the ear. In this fluid, having nearly the shape of the part in which it is found, but not being as large, is a sac, bag or membrane, which is filled as well as surrounded by the fluid. In the sides of this sac, nerves commence, as some say, directly at its surface, as others say, just beneath its surface. From all these points they converge and form one bundle, which leads from the labyrinth to the brain. In fig. 8, the labyrinth *l*, is represented as a mere box, filled with fluid, and the nerves *n* represented as if suspended in it.

28. *That the boy may hear, six things are necessary*—1. Some object to act on the air and cause it to vibrate. 2. The air. 3. The ear (called the organ of the sense of hearing). 4. The nerves. 5. The brain. 6. The mind. (The effect produced on the mind is called a sensation.)

[That the agitation of the air will act on the membrane, 1, fig. 8, is

ear. *Inf.*? Describe fig. 8. ¶ 28. That the boy may hear, how many things are necessary? 1st? 2d? 3d? 4th? 5th? 6th? What is evident? Upon what do not

evident enough. Also that any agitation of the fluid of the labyrinth will act on the nerve is evident, but strange to say, all do not yet agree how the outer membrane of the drum-head, acts on the inner drum-head. A person would at first say, it is by means of the chain of bones. But persons have been found to hear, when the bones had been destroyed by disease. One thing is evident; from the number and complicate arrangement of the ear, there must be many causes for its derangement.* There are two very frequent causes of deafness. 1st. Allowing the ear-wax to collect in the outer tube. This evil can be removed by dropping a little sweet oil into the ear, and retaining it with a bit of cotton or wool or the like, for a few hours, and then syringing out the ear with Castile soap and warm water. This, frequently repeated, will answer the purpose. 2d. Still more frequently, partial or entire deafness is produced by what is termed taking cold. When this is observed to be the cause, care must be taken to avoid more cold, as this will be the only thing of use. Hardness of hearing is apt to follow any extensive disease which exhibits itself in the upper part of the throat, especially in childhood. Such deafness, if not too severe, the child is apt to outgrow, provided care be taken that it do not catch cold.]

29. *The use of the sense of hearing* is in the first place to enable a person to gain assistance when in distress.

Inf.—The effect of tones of distress should be to awaken emotions of kindness and pity, and induce us to give immediate relief, if in our power.

Illus. a.—The tones of a suffering child powerfully affect the mother, and indeed almost any person.

Illus. b.—The hen runs at the call of her brood.

30. *In the second place, the sense of hearing is of use*, in warning us of near dangers.

Illus.—If the engine be coming down the track, we wish to be informed of it.

[As the danger is sometimes very sudden, we ought, through the ear, to be roused to vigorous action.]

* What impostors those people must be who tell us their ear-oils or any thing else is a sure cure for deafness. Is it not *worse than stealing* to get money in such ways?

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all agree? Foot-note? 1st cause of deafness mentioned? 2d? ¶ 29. Use of sense of hearing? *Illus. a?* *Illus. b?* ¶ 30. In the second place, what is the use of hearing?

Illus.—How the boy jumps, when unexpectedly you shout close to his ear!

31. *In the third place the sense of hearing is of use*, by making us to judge if a person feel angry with us.

[When a person feels angrily toward us, there is danger that he will strike, or in some way injure us.]

Inf.—An angry voice ought, through the ear, to rouse the mind to opposing action.

[It will do so, and nothing will act more powerfully on the mind than an angry, vexed, or fretful tone of voice. It is so as well with animals as man. Speak harshly to a horse, no matter if the language be Latin, and he will manifest fear or crossness, etc.]

32. *In the fourth place, the ear is of use*, by informing us when persons about us are pleasantly disposed towards us.

[Being in no danger, we ought to repay kindness with kindness, the effect of pleasant tones of voice through the ear, ought to subdue crossness, anger, fretfulness, etc., and they will, to a great degree, in case of man or beast.]

33. *In the first, second, and third places*, the sensations should be unpleasant.

Inf. a.—If we do not relieve distress we must feel unpleasant sensations, from our very constitution.

Inf. b.—We ought never to cause others to feel unpleasantly by our angry or fretful tones of voice, for not only will it tend to their unhappiness, but by causing them to answer us pettishly and fretfully, cause our own unhappiness to be increased.

34. *In the fourth place*, the sensations should be pleasant.

Inf.—It will be as much for our own benefit as for others that we produce pleasant tones of voice, for our pleasant tones, by causing others to feel pleasantly, will make their tones pleasant to our ears.

Illus.—What a delightful state of feeling a pleasant person will diffuse through an entire circle.

Inf.—One way to make others love us is to always speak pleasantly

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What ought to be the effect? *Illus.*? ¶ 31. In the third place? When a person feels angrily, what is the danger? *Inf.*? What will be the effect of angry or fretful tones? ¶ 32. Fourth use of the ear? ¶ 33. When should sounds be unpleasant? *Inf. a*? *Inf. b*? ¶ 34. When should sounds be pleasant? *Inf.*? *Illus.*? *Inf.*? ¶ 35. How

to them, because thus making them feel happy in our society, they must love us, and loving us will desire to gratify us.

[Through the portals of the ear also, the most enrapturing and controlling sensations are produced by musical sounds. The shrill notes of war will stir the mind in a wonderful manner, while the concordant harmony of sweet voices will tranquilize a disturbed spirit to a degree almost beyond belief.]

35. *To please the mind through the ear*, we should cultivate and use a pleasant tone of voice at all times. We should, if possible, also cultivate a talent for making melody with our voices by singing, or on instruments by playing them. We should especially cultivate a taste and fondness for musical sounds.

[Not only that made by the human voice and musical instruments, but also nature's melodies—of the sweetly singing birds, the moaning woods, the gurgling brooks, and the dashing waterfall, the lowing kine, bleating sheep, and a thousand of these things which enliven the world. Many a man sighs for the pleasure which he fancies is attendant on the possession of money, and entirely overlooks the gratuitous wealth which nature would gladly bestow upon him; let him open his ears and allow delight to flow in upon his mind from every object that has a voice. If he wish a happy home (the best wealth) let him put off his envious, complaining, despondent, discordant tones of voice; let his tones be cheerful and lively, and happiness-causing; let him cultivate in himself and his family a taste for music and ability to make it, and let the pleasant and grateful tones of his voice be raised in thankful praise to his Creator for the undeserved wealth he possesses, and then if he find God is not good, let him complain.

CHAPTER IV.

Organs of the Sensation of Smell.—The Nose, Nerves, Brain.

[Suppose the fields to be covered with the freshly blossomed clover. As the boy snuffs in the air how delicious the sensations he feels. Why?

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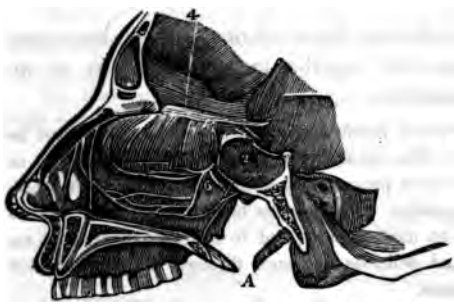
please the mind through the ear? When may a person complain? If the clover be

Small particles from the clover-heads fill the air, and with it pass into his nose.]

THE NOSE.—This organ of the body is lined with a very delicate skin or membrane, just beneath the surface of which, as in case of the skin heretofore mentioned, a multitude of nerves commence. They pass up through small holes (like as in a sieve) in the top or roof of the nose, and which also forms a small part of the skull. As soon as they have passed through these holes, they all unite and form what is called the olfactory (smell) nerve. This extends back to the brain with which it is united. Another kind of nerves also commences in the lining of the nose, like, and for the same purpose as those commencing in the outer skin. They of course connect with the brain, but not in the same place.

Fig. 9.



36. *That a person may have the sensation of smell produced*, six things are necessary—1st. The small odorous particles. 2d. The air. 3d. The nose (the organ of smell). 4th. The nerve. 5th. The brain. 6th. The mind. (The effect produced on the mind is called a sensation.)

[In case of certain animals the sense of smell directs them in the selection of food, &c, but in case of man,]

37. *The sense of smell does not seem to be of much decided use.*

38. *Odors are very powerful in producing pleasant or unpleasant effects of sensation.*

39. *The effect any odor will produce* depends in part on our natural constitution, in part on our habits, in part on our health, and somewhat on a variety of other circumstances.

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in blossom, why does the boy feel delightful sensations? Describe the nose. ¶ 36. How many things are necessary, that a person may smell? 1st? 2d? 3d? 4th? 5th? 6th? Is the sense of smell acute in animals? How does the hound follow the fox? ¶ 37. Is it of much use, apparently, in man? ¶ 38. How are odors powerful?

[Few people are aware of the great control produced by sensations of odors upon the mind. It seems a little thing, yet it has great influence.

40. *The odor of food in preparation*, if agreeable, causes it to be better relished, and more easily digested.

Inf.—Food should be so prepared that, when placed on the table, its odor shall be grateful.

41. *The art of pleasing the mind through this sense* consists in mingling articles together in such a way as to increase their good qualities.

[This, however, depends much upon taste and habit. We must be careful not to offend. The breath produced by smoking, chewing, or snuffing tobacco, is to most persons very offensive. So also is that produced by drinking alcoholics. On the other hand, the odors of flowers are highly agreeable to most persons, and to cultivate them about us diffuses a freshness and delicious fragrance through the air, that adds much to home attractions.

CHAPTER V.

Organs of the Sensation of Taste.—The Mouth, Nerves, and Brain.

[If the boy pick a clover head and place it in his hand, he feels that it is there; but if he put it in his mouth, he not only feels that it is there, but says it tastes sweet.]

Just beneath the surface of the skin of the tongue and back parts of the mouth, certain nerves commence, which extend to the brain, and are called the nerves of taste, to distinguish them from certain other nerves of touch, which resemble and are of the same use as those commencing in the skin.

42. That a person may taste, five things are necessary—1st. The object tasted. 2d. The mouth,—through the skin of which—3d. The nerves are acted on, (producing what is called an impression). 4th. The brain. 5th. The mind (the effect upon which is called a sensation).

¶ 39. Upon what does the effect of odors depend? ¶ 40. Odor of food? ¶ 41. The art of pleasing the mind through this sense? What is said of the odors of plants? Describe the mouth. ¶ 42. That a person may taste, how many things are necessary?

43. *The use of the sense of taste is, in the first place,* to cause the food to be relished, and thus change a duty to a pleasure.

44. *The use of the sense of taste is,* in the second place, to cause the food to be more easily digested.

[For it is found that all other things being similar, the better the food is relished the more easily will it be to digest.]

Inf. a.—We ought to cultivate a relish for wholesome food.

Inf. b.—We should take pains to have wholesome food cooked in such a way that it will relish.

45. *A good appetite* is one of the most powerful means of causing food to relish.

Inf.—We should strive to produce a good appetite in a healthful manner.

46. We are so constituted that there is a certain natural order in which food ought to be eaten, in order that different kinds may relish in the highest degree.

Illus.—It is said that cheese is eaten before wine to improve the taste of the latter, while sweet cake makes the best wine taste insipidly.

47. *The art of pleasing the mind through this sense,* consists in properly producing a good appetite, and in cooking wholesome food in such a way, and arranging it in such order on the table as to have it relish to the highest degree.

[This is not an unimportant matter. It is not costly cooking which is most relishable by any means. It is the right flavoring of food, and proper attention in preparing it. Too much salt in the butter will spoil an entire repast. Too little yeast in buckwheat cakes spoils a breakfast. What is the result? Perhaps a great deal. Suppose a business man has eaten such a breakfast; not relishing it, he goes to his business in not the pleasantest mood of mind. He cannot treat his customers as urbanely as they wish, and they go somewhere else to trade. To make home desirable, let the table be neatly set forth with well cooked food.

1st? 2d? 3d? 4th? 5th? ¶ 43. First use of taste? ¶ 44. Second? ¶ 45. What is the most powerful means of causing food to relish? *Inf.?* ¶ 46. How are we constituted? *Illus.?* ¶ 47. What is the art of pleasing the mind, through this sense?

Our Creator intended we should enjoy our food, and it is wrong to spurn one of his blessings. Since also every one knows that exercise and exposure to the fresh air produce an appetite, let us seek by this means to increase the pleasures of life.]

CHAPTER VI.

Organs of the Muscular Sense.—Muscles, Nerves, Brain.

[Before the boy went out to play with his kite, he felt very desirous to go—he felt as if he must have a chase. When he obtains permission to go how happily he bounds away, but by and by he will say he feels tired, and will go and sit down again with pleasure. Why is all this? What is the occasion of his feeling tired? Let us see.]

THE MUSCLES.—This is the name given to pieces of lean meat, which in animals as well as man are found within the skin, and compose a large part of the body. See fig. 1, Pl. 1. They are always in use when a person produces motion. In all parts of them we shall find nerves commencing, which can be traced to the brain; they join those coming from the skin, and with them, for the most part, enter the back-bone and unite with the spinal marrow.

48. *That a sensation may be caused through the organs of the muscular sense*, four things are necessary,—1st. A muscle. 2d. A nerve (the effect produced upon which being called an impression). 3d. The brain. 4th. The mind (the effect produced upon which being called a sensation).

49. *The kinds of sensation produced through this sense are threefold.* 1st. An unpleasant sensation is produced when the muscle is not used enough for its good. 2d. A pleasant sensation is produced when the muscle is properly used. 3d. An unpleasant sensation of fatigue is produced when the muscle has been long enough used.

50. *The use of this sense is* to inform us how much motion has been produced by any muscle (and thus to a degree we gain an idea of the consistence of things), to inform us when

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When do you feel tired? What are the muscles? ¶ 48. What four things are necessary, that muscular sensations may be caused? What kinds of sensation are produced through the muscular sense? ¶ 50. What is the use of this sense? ¶ 51. What is

the muscles are not used as much as they should be, and when used too much, and finally to increase the pleasures of existence.

51. *The art of pleasing the mind through this sense*, consists in using the muscles to a proper degree.

[This is a matter of great importance. Many persons do not enjoy life as they ought, because they will not take sufficient exercise. Others take too much exercise, and others again there are who exercise certain muscles too much, and certain muscles not enough.]

Illus.—A seamstress, a shoemaker, or any person who sits steadily all day at work.

[A restless, torpid state of mind will be produced when persons confine themselves all day to the house. His lot is not hard, who, by manly exercise produces a lively, contented state of mind, and drives away that listlessness which weighs down the indolent. The Creator never intended the industrious to go unrewarded. On the other hand, the person who is too zealous to grow rich speedily, and who works laboriously, may lay up money in store—but this does not make him truly wealthy. He who labors aright enjoys his wealth as he acquires it, and possesses an increased stock the more he enjoys it. Let, then, no persons, young or old, think to enjoy life if idle or overworked—if taking too little or too much exercise. It is contrary to the laws of our Maker.]

CHAPTER VII.

Internal Organs of Sense.—All Parts of the Body.

52. *All parts of the body may be considered as organs of sense.*

[For nerves commence in all parts of the body and lead to the brain. Any state of disease, or health of any part, can thus produce effects on the brain and through it on the mind. As by this means a knowledge of the

the art of pleasing the mind, through this sense? What is said of many persons? *Illus.*? What is said of him who labors aright? ¶ 52. Is a bone an organ of sense?

state of any part of the internal portions of the body is, to a greater or less degree, made known, we may very properly speak of internal organs in distinction from those by which the mind gains an idea of external objects.]

53. *The sensations produced through these organs* are of two general classes,—pleasant and unpleasant.

[Unpleasant when parts of the body are unhealthy or improperly acted upon. This is not, however, always the case; sometimes extensive disease will exist and not cause any pain. Pleasant sensations are for the most part produced by a healthy condition of various parts of the body. Sometimes an unhealthy state produces pleasant sensations, as when a person has used some kind of poison, such as alcoholics, tobacco, opium, tea. These are all therefore very deceptive, for though their first acquaintance is very captivating, they leave a sting behind. Pleasant sensations, produced by causes of a healthful character, never leave an injury.]

54. *To please the mind by means of the internal organs of sense*, we must preserve all parts of the body in health, by taking proper food, drinks, air, exercise, &c.

[If persons would consider how much pain and unhappiness an unhealthy mode of living will produce, it seems as if they would abandon it, especially if they would likewise consider that a proper mode of life is more productive of immediate and ultimate happiness.

Review of the Organs of Feeling.

55. *To produce a feeling in the natural way* through any organ of sense, five things are to be observed. 1st. That there be an object to act. 2d. The commencing points of nerves, to act upon. 3d. The nerves through which effects are produced on the brain. 4th. The brain, by means of which the mind is directly acted upon. 5th. The mind.

Why? ¶ 52. What kinds of sensations are produced through the nerves, commencing in the internal organs? When are unpleasant sensations caused? When pleasant? Can all pleasant sensations be considered as produced by healthy causes? ¶ 54. How can we please the mind, through the internal organs? If people would rightly consider, what would be the result? ¶ 55. To produce a feeling in the natural way, what

56. *If we could examine the brain accurately*, we should find doubtless, that the different classes of sensations produced are caused through different parts of the brain which differ in their construction.

57. *The nerves through which the different classes of sensations are produced* essentially differ from each other in several respects..

[In color, however, and all *general* respects, they almost or perfectly resemble each other.]

58. *The external organs of sense in which the nerves commence* are of six different classes, being adapted to allow particular objects or qualities of objects to act on these nerves to which they are adapted.

Illus. The nerve of the eye is the only one in the body which is adapted to the action of light. Light will not produce any sensations if acting on the nerves of the skin, or nose, etc. The eye is also so adapted, that through it alone can light be of any utility.

Inf.—If any nerves in the body were precisely like those in the eye, except an eye were in front of them they would be of no use in seeing.

59. *But as the brain acts directly on the mind*, if any cause produce such a state in any part of it, as an object acting naturally through the organ of sense would do, there must be a similar sensation produced in both cases.

[Hence in certain diseases of the brain, a person thinks he hears sounds and sees sights which do not really exist.]

60. *As the nerve is the part which acts directly on the brain*, if any cause produce such a state in the nerve as an object acting naturally through the organ of sense would do, there must be in either case a similar sensation produced.

Illus.—If a boy fall and jar the nerve of sight, the same state is produced as if light from sparks had been acting through the nerves. Hence he says he sees sparks.

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five things are necessary? ¶ 56. What should we doubtless find true of the brain? ¶ 57. Are all nerves alike? How do they appear? ¶ 58. How many classes of organs of sense are there? Name them. *Illus.*? *Inf.*? ¶ 59. If a certain state be produced in the brain, what? What is produced by certain diseases of the brain? ¶ 60. Through

Inf.—We cannot always be certain from our sensations of their cause.

61. *Through all the different classes of organs of sensations*, pleasant and unpleasant sensations may be produced. The unpleasant ones being for the most part to warn us of dangers to which we are exposed, or to give notice of harmful causes from which we are suffering. The pleasant sensations are, for the most part, conducive to health, and form not a small share of the happiness or wealth, which, when possessed, makes life a blessing.

Inf.—In selecting an avocation, we should be careful to choose one, the tendency of which shall be to surround us with objects productive of pleasurable sensations. We should also, for our own happiness, cultivate a taste for neatness and order, and a susceptibility to the action of all and every cause of pleasurable and healthful sensations. We should keep our private rooms in as good order as those which are exposed for public admiration. We should exhibit all the urbanity of refinement at home as much as abroad, and should treat those with whom we are intimate with the same considerate politeness with which we treat strangers, and never through indolence or neglect fail to please through the organs of sense, especially since it is so easy a matter to do.

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what is the brain directly acted upon? What follows? *Illus.*? *Inf.*? ¶ 61. Through what organs of sensation cannot sensations be produced? What are unpleasant ones for? Does a painful tooth cause you to relish your food better, or worse? Does any unpleasant sensation improve health? *Inf.*? What occupation would you prefer? Why? What pleasurable sensations does it cause? What unpleasant ones would naturally be connected with it? How should we keep our private rooms? How should we treat all?

BOOK II.

The Means by which the Mind Thinks.—The Cerebrum (Large Brain), and Cerebellum (Small Brain).

62. *The brain is proved to be the part used by the mind when thinking*, by—1st. When certain injuries and diseases effect the brain the thoughts become irregular, and sometimes entirely cease. 2d. When thinking, intense sensations are felt by a person as if in the head. 3d. When in intense thought, blood flows to the head in large quantities, and it becomes hot. 4th. When by accident the brain has been exposed, its activity has been seen to depend on the thoughts of the person. 5th. As it has been shown that the nerves through which feeling is produced concentrate at the brain, and as it will be shown that the nerves by which motion is produced extend from the brain, it will be seen that the brain ought to be the location of the thinking mind.

[How the mind uses the brain in the process of thinking we cannot with our present knowledge determine, more than we can know how through the nerves the mind is so acted upon that sensations are caused. Some persons judge that, sometimes at least, the mind can think without the use of the brain. Others will ask—How do we know there is a mind? Cannot all thinking be accomplished by the brain alone? If there be a mind, what color is it, what shape, &c.? As if a thing must necessarily have color or weight in order that it may exist. As well might a deaf person ask what odor, or sound, or weight light has, and disbelieve in its

¶ 62. How is the brain proved to be that part by which the mind thinks? How does the mind use the brain? How do we know there is a mind? *Illus. a.*? *Illus. b.*?

existence because he could not take it in his hand. We feel the effect of the mind's action, as distinctly as we do that of light. The feelings produced by the two, are of course different, and are produced in different ways. When light acts, it acts on the eye, and through the nerves of it; when the mind acts, it acts on the brain, and the brain then acts on the mind, producing sensations. The only way we know that we think, is by knowing that sensations are produced. That the proper action of the brain will produce such sensations, is evident from the effect of opium, alcoholics, and various other poisons.]

Illus. a.—If a person of a certain constitution and disposition inhale ether, he will begin to feel very pleasurable sensations—similar to those produced by the mind when the emotions are active.

Illus. b.—When certain diseases affect the brain, the sensations are similar to those caused by activity of the mind.

[That there is a mind, seems to be conclusively proved also, by the fact, that (as will be shown hereafter) the brain is constantly undergoing changes, while a person can remember the events of an entire lifetime, and he only knows many items of his personal existence. There is also proof in this, viz., a person can give his attention to any class of sensations, to the entire exclusion of others.]

Illus.—A person may be so engrossed with reading or the like, as not to hear another person who addresses him.

[Perhaps, however, this may be accounted for, by supposing that different parts of the brain are required in accomplishing different classes of duties, and that a certain amount of blood is requisite in the fulfilment of their duties, that when any part is active extraordinarily, it obtains a large amount of blood, and leaves some other part with too small a quantity to fulfil the duty of causing sensations.]

Illus.—If a person take exercise while eating, or immediately after, the exercised parts require so much blood that the proper quantity is not received by the stomach, and the process going on there is consequently delayed. Though this illustration is not exactly to the point, it exhibits the idea desired.

[So little is known of the requirements of the mind, in the process of thinking, that we cannot prejudge how the brain should be formed or what will be for its good. We can only examine the brain in a general way, and thus learn somewhat how to treat it. We may likewise class

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How farther is it proved there is a mind? *Illus.?* How, perhaps, may this be ac-

together a large number of facts, and from them deduce certain inferences of great value.]

Fig. 10.

THE BRAIN is found within the skull, and is about three-fourths the size of the head. There is, however, so much difference in the proportionate size in case of different persons, that the size of the head is not a criterion by which accurately to determine the size of the brain.

The outer surface of the brain is much like that of a peach stone or the meat of an English walnut in appearance or as shown by fig. 10. It is of a cream or ash color. Viewed from above, a deep fissure is seen, in which a partition is found, which being attached to the skull, and stretched tightly, supports either half of the brain as we recline on either side. As the halves of the meat of a walnut are united by what may be termed a bridge, so if we go down this fissure, we find it extends two-thirds of the distance to the bottom of the skull, when the two halves of the brain begin to be united. From the front and back the fissure extends one-third the length of the brain, as shown by fig 11, where the brain is represented as if sliced off to a level with the bridge *d d*. By this fig. it will be seen that the inside of the brain is white. If it be sliced away still more as in fig. 12, certain parts named ventricles, and sometimes called cavities, are found. Their sides are in contact, except separated by unnatural collections, which are sometimes found in them. The ventricles are curiously shaped, and the fingers can be passed about in them for some distance into the bottom and sides of the brain. The bottom and sides of them are formed of singularly shaped and colored masses which have been fancifully named, but their use is not known. In fig. 12, A A is the skull, C C the gray part, and D D the white part of the brain. F F E G, different parts of the right and left ventricles—but none of these parts are as uniform as here represented. The skull is sometimes more than twice as thick in one place as another, and so likewise is the gray part. If we take one-half of what we have thus far described from the skull, we shall see (fig. 13) that the side toward the other half is uneven like the outer surface. If we look at the bottom we find the same thing true, while the general form is very irregular. The front and sides of this brain rest almost directly on the skull; the back part rests on what may be called a shelf that comes forward from the skull, and is tightly stretched in its place. (Its name is the Tentorium.) The partition (called Falx) between the two halves, is attached to its upper surface. Thus it will be seen that the skull is divided as it were into three parts, all of which open into each other in the centre and lower parts of it. Below the shelf, what is called the small brain (cerebellum) is found. This weighs about one-ninth as much as the larger one. Its outer surface is quite smooth, striped with white and cream color. When cut open, this is seen to be owing to the alternate layers of white and gray substance of which it is composed. It is slightly indented at the back part, and at the front is connected with the upper part of the spinal cord which extends into

Fig. 11.

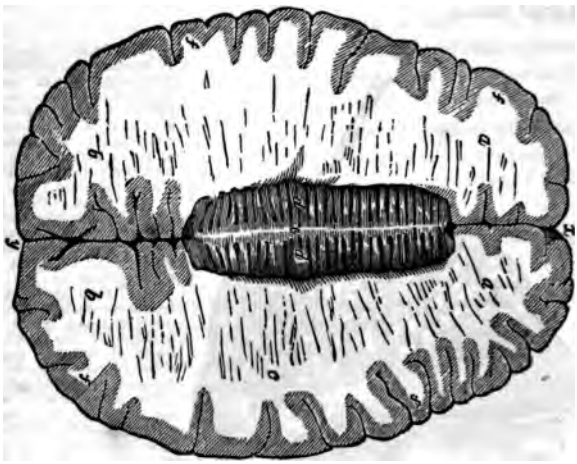
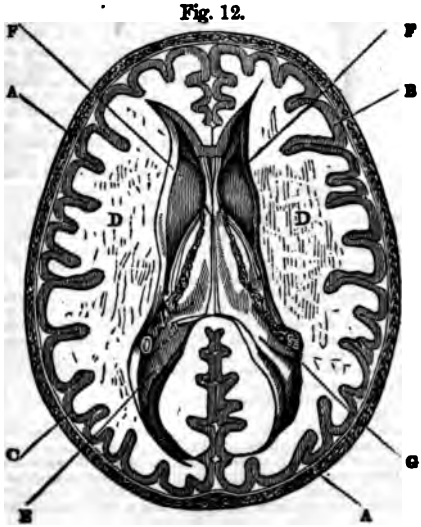


Fig. 12.



the skull. The particular name of this part of the cord is Medulla Oblongata (oblongated marrow). It is also thought that there is at this place a connection between the large and small brains. When the brains are taken from the skull they flatten down somewhat, being about the consistence of a jelly, &c.

63. *It is very important that the brain be protected from injury*, especially from jars.

Fig. 13.

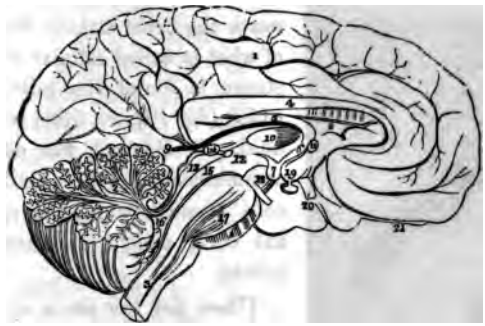
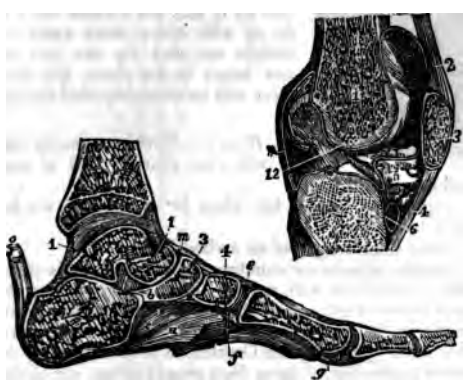


Fig. 14.



64. *To prevent the effect of jars and blows*, there are various means found in the body. 1. The bones are full of larger or smaller cells, as seen in fig. 14. 2. These cells are filled with marrow. 3. The bones are of such shape, and so bent at the joints when we walk, that the force is scattered, as in the direction of the dotted lines, fig. 15. 4. There are between the bones of the back 22 cushions, which act like springs. 5. The skull is of such shape (arched) in all exposed parts, as to resist the effects of blows. 6. The skull is composed of three layers of different texture,

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counted for? *Illus.* ? Describe the brain? ¶ 63. From what is the brain very liable to receive injury? ¶ 64. How is the effect of jars prevented? *Illus. a.*? *Illus. b.*?

Fig. 15.

fig. 12. 7. The head is covered with hair, &c. 8. Underneath the brain a thick layer of what is called cellular substance is found, the cells of which (fig. 16) are filled with fluid. 9. Beneath the cells communicate with similar cells found around the spinal cord, except at certain points.

[These last two are a superlative contrivance.]

Illus. a.—Hang several ivory balls in a row by strings, raise one and let it fall, the further one will fly off with force—take away the middle one, and tie the heel (or any bone) in its place, but little force will be communicated through it.

Illus. b.—Strike an empty vial, it will ring sharply; fill it with marrow, and a dead sound will result.

Illus. c.—How unpleasant the jar felt, when by a misstep we fall with our feet directly beneath us.

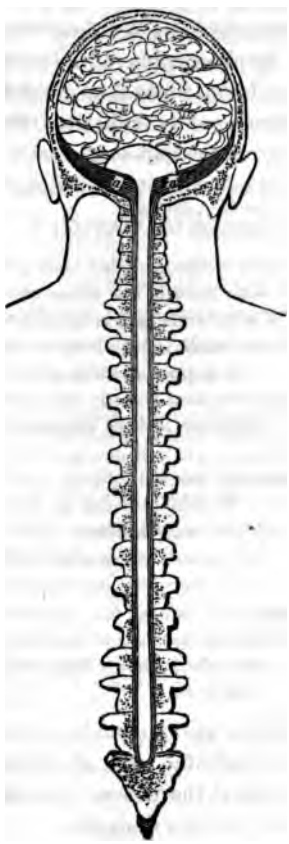
Illus. d.—How great the strength of an arched bridge.

Illus. e.—In hospitals, patients are sometimes placed on what is called hydrostatic beds, viz., beds filled with water. From the upper to the lower side, pieces are fastened to prevent the water from running to one side. Thus the bed is made as it were into cells. When such extraordinary pains have been taken by our Creator to prevent jars of the brain, we should never unnecessarily jump from great heights, nor should we give or receive avoidable blows upon the head. Even a cuff may sometimes injure.

[As it is necessary that the boy should think, in order to extract the thorn, and save his foot from further injury—as it is also necessary for him to gain knowledge of the effects of opium, alcoholics, and other poisons, that he may be able to avoid them, and as knowledge in every

Illus. c.? *Illus. d.*? *Illus. e.*? ¶ 65. How ought we to be constituted? ¶ 66 When

Fig. 16.



department of life is necessary to our success, and that we may make ourselves and others most happy, we ought to be so constituted that]

65. *When the mind is gaining or applying useful knowledge* in a proper manner and degree, the brain is in the best state, and will be the cause of pleasant sensations.

66. *When the brain is not exercised to a proper degree*, an unhealthy state is produced in it, and also unpleasant sensations by it.

67. *When the brain is exercised to too great a degree*, an unhealthy state ought to be, and will be produced, and also unpleasant sensations.

Inf. a.—An ignorant man must be unhappy.

Inf. b.—A good education is desirable on its own account, and the immediate effect it produces on him who acquires it.

Inf. c.—A person who applies his mind too assiduously, is not a gainer, but a loser.

[But when we hear the shouts of the boy, we realize that something besides intellectual operations are performed by the boy's mind. We know that his emotions are active, and every one knows how great is the pleasure attendant on certain emotions,

and how unpleasant the effect of certain other emotions—it is therefore evident that]

68. *Those kinds of emotions which are beneficial to ourselves and others*, are attended by pleasurable sensations, and produce a healthful state of the brain, while those which are injurious to ourselves and others, produce unhealthy effects on the brain, and sooner or later unpleasant sensations.

Inf. a.—A good education does not consist merely in cultivating the intellectual powers of the mind, but also the emotional.

Inf. b.—To be a happy man, a person must be a good man.

[I do not believe any thing to be more certain, than that vanity, pride, slighting others' feelings, avarice, and other more or less vicious traits of character, make a man unhappy. While the outer garb is splendid, misery often gnaws at the heart. To have much is not always to enjoy much. Envy also frequently destroys the happiness which would live in the merry heart of benevolence. He who lives honestly and actively, shall enjoy the rich reward of much happiness, and the assurance that "honesty is the best policy."

But we find after a time, that continued emotion fatigues us, and so it should be, since life is full of duties. We find also that at different times we are differently pleased with the same emotions. The boy thinks, when he comes to be a man, and must sit still a whole evening and talk, or read in a great book, it will be very prosy, and nothing like as pleasant as playing ball, or blind-man's buff, skating, etc. It is not so; as he grows older, if he be properly educated, he will find that his hours pass more and more pleasantly. The boy who is skating enjoys not the half which the father does who watches his sports.]

69. *We ought so to cultivate our various intellectual and emotional characteristics*, that a healthful state of the brain shall at all times be produced, and at the various periods of life render sensations pleasurable and life desirable.

[If we take notice of all that has been said, we shall find that]

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the brain is not properly exercised what is the effect? ¶ 67. When the brain is exercised to too great a degree? *Inf. a.*? *Inf. b.*? *Inf. c.*? What kind of emotions produce pleasurable sensations? Should they do so? *Inf. a.*? *Inf. b.*? What does the author believe is certain? What is the effect of continued emotions? If a person be properly educated, what is the effect as he grows older? What if he be not properly

70. *There are produced on the mind, four grand classes of sensations.* 1st. Those produced by the health—pleasant in case of good—unpleasant in bad health. 2d. Those produced by external objects. 3d. Those produced by emotions. 4th. Those produced by intellectual action.

71. The first class is produced during all periods of life —we are never injured by their continuance, and they are a great source of happiness.

Inf.—In case of the youngest child, by promoting its health we promote its happiness.

72. *The second class is produced in early childhood,* and is in early life much more intense than at its close. The mind may be gratified with them for almost any length of time, without satiety or injury.

Inf.—Young children should be pleased by a succession of proper objects, addressed to their organs of sense, and thus have their happiness and enjoyment of life increased, and a good disposition cultivated.

73. The third class of sensations begins to be felt in early childhood, and the causes which produce such a class as is then felt, may be very actively cultivated without harm.

Inf.—All the emotional characteristics of childhood should be actively cultivated, especially those which should continue through life, that thereby a child may enjoy more while a child, and likewise have those characteristics which adorn matured years so strengthened that they shall not be withered or blighted when brought into contact with the world's breath.

74. *The fourth class of sensations is produced by* causes not exhibited in the earliest periods of life, and are not in full action until near its maturity.

Inf.—In childhood, the intellect should be but lightly cultivated, while as a person advances in years he will find more and more pleasure derived from assiduously cultivating it.

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educated? ¶ 69. What ought we to do? ¶ 70. What classes of sensations are produced on the mind? ¶ 71. When is the first class produced? *Inf.?* ¶ 72. When is the second class produced? *Inf.?* When is the third class produced? *Inf.* ¶ 74. When is the fourth class produced? *Inf.?* When is there need for the exercise of

[While a child, he is cared for and watched over by some one older and experienced; hence there is no necessity for the exercise of his intellect. Application of the child's intellect therefore, except in the most cautious and natural manner, is found to be contrary to his well being, not only causing ill health in the overtasked brain, but by producing unpleasant sensations, causing the child to conceive a dislike for intellectual tasks, which unfortunately, it sometimes never overcomes. It will be again seen hereafter, why the child's brain should not be overtasked.]

75. *When we choose an occupation for life*, we should be careful to select that which will be most conducive to health, and the proper cultivation of the organs of sense and intellectual emotions.

76. *If the occupation be not of such a sort as to accomplish all that is desirable*, we should join with it, either as a task or a pleasure, some pursuit which will compensate for its short-comings.

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the intellect? ¶ 75. Of what should we be careful in choosing an occupation for life? ¶ 76. If the occupation be not favorable what should be done?

BOOK III.

MEANS BY WHICH THE MIND CAUSES VOLUNTARY MOTION.

[To produce the motions exhibited by the boy when extracting the thorn, in the first place a framework strong, yet light, and composed of pieces jointed together so as to move one upon the other, is required. In the second place, there must be something to move these various parts. If we examine the leg of a chicken or a similar animal, we find certain cords, called tendons. Every boy has amused himself by pulling these, and learned that by pulling one, the claw is opened, while by the other it is closed. If he should follow the cord up the leg of the chicken, he would find it apparently terminating by becoming connected with one of the pieces of lean meat which help form the leg. This meat is called a muscle, by following which he will soon find its upper end, which also terminates in a tendon, and this grows to the framework of the upper part of the leg.

Since then one end of the lower tendon is attached to the toes, and the upper end of the upper tendon is attached to the upper part of the leg, and the muscle by each end attached to the tendons, if the muscle should be shortened it would pull upon both tendons, and either move the toes or the upper part of the leg, or both at the same time towards each other. This is what takes place when the chicken shuts its claws. The same principle prevails when we produce any motion, as when, for instance, a person places his hand on the front part of the upper arm of the other side, and at the same time raises the hand and lowers the arm. He will perceive that the muscle he is grasping shortens as he raises his hand, and relaxes as the hand falls. See fig. 17. E is the joint of the elbow, T T are the tendons at the two ends of the muscle B, which are attached to two parts of the framework, having a movable joint to connect them; when, therefore, the muscle is contracted, the motion of rais-

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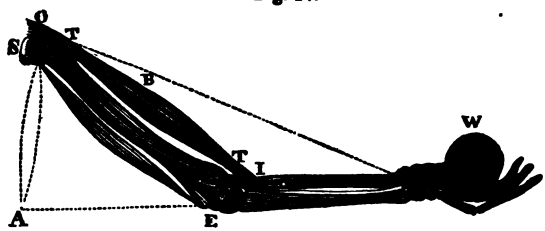
To produce motion, what is necessary? Did you ever examine the leg of a chicken? Describe how it appeared? Who will bring one prepared to show what is said of it?

Fig. 17.



the lower arm must take place. To produce the powerful and rapid motions we desire with the greatest ease, the muscles must be very strong, and contract with the quickness of lightning. But the muscles of the various parts of the body are at quite a distance from the brain where the mind dwells, therefore it is necessary that there should be certain ways for the mind to act from the brain upon the muscles, and cause them to act as is desirable. If we examine the muscle narrowly, we shall find that it is connected with the brain by certain white cords, called nerves. These are the means of communication from the brain to the muscle.]

Proof.—If the nerve be cut, the mind can no longer cause the particular muscle to contract.

[But how shall the mind act through the nerves? The brain we find to be necessary, since if it be disordered the motions always become irregular. The apparatus by which the mind produces motion, may be considered under five heads, since to produce motion there are necessary, 1st. A framework. 2d. The muscle and tendons. 3d. The nerves. 4th. The brain. 5th. The mind.]

CHAPTER I.

The Framework—Bones, Cartilages, Ligaments.

77. *The uses of the framework (called the skeleton), are to give form—support the various parts of the body, and allow motion with ease and gracefulness.*

Describe fig. 17? How can any motion of the body be produced? How do we draw down the head? How do we roll down the eyes? How do we raise the foot? Does the mind act directly on the muscle? How does it? What connects the brain and muscle? Proof? What parts are now to be considered in the production of motion?

Inf. a.—Since the form is essentially produced by the skeleton, a person desirous of possessing a beautiful form, should produce and preserve a good framework.

Inf. b.—It must be very interesting to every person to investigate the structure and condition of the skeleton, and learn what conduces to its welfare.

SEC. 1.—*The Bones.*

78. *The bones are the firmest and most resisting parts of the framework*—exceedingly light and strong, and of such forms as admirably to protect each part, and the whole body from injury.

The bones are composed of two classes of substance. 1st. A very flexible substance, like the framework of the ear, and like it called cartilage. Its proportion is very great in early life; less and less as a person advances in years. 2d. A marble-like, or chalky substance, which exists through the whole bone in small quantities early in life, but in constantly increasing portions as a person advances towards old age.

79. *The use of the cartilage, or the cement part*, is to give strength with a slight flexibility and elasticity to the bones.

80. *The use of the marble or earthy portion* of the bone is to give it stiffness and resistance, and in old age to render the bones brittle and easily broken, and thus prevent the serious jars which the brain of an old and inelastic person would otherwise receive.

Inf. a.—In infancy, the earthy portion existing in very small proportions, the framework of the child cannot support weight without harm, hence the child that has not a natural inclination to walk, should not be placed on its feet with the hope of teaching it early to "*go alone.*" Nor should the infant be allowed to lie long in any one position.

Inf. b.—It is impossible for the bones to be well formed, unless the child receive the right kind of food.

Inf. c.—If a child be very fat and heavy, deformity may be the result.

Ex. a.—Put a bone in the hot fire for a short time; upon taking it out, it crumbles with the slightest force. The heat has removed the cartilage.

Ex. b.—Place a similar bone in diluted muriatic acid; upon taking it out, it will be found that the earthy part has been entirely removed, and the cement part left, which is almost as flexible as india-rubber.

81. Although the bones are so perfect, they are frequently

¶ 77. What are the uses of the framework? *Inf. a?* *Inf. b.?* ¶ 78. Describe the bones generally? How are bones composed? ¶ 79. The use of cartilages? ¶ 80. The

broken and bent, and often allow the brain to be severely jarred when they receive a blow.

Inf.—We should be careful not to jump from great heights, and not to receive severe blows, such as are frequent in wrestling, snow-balling, &c.

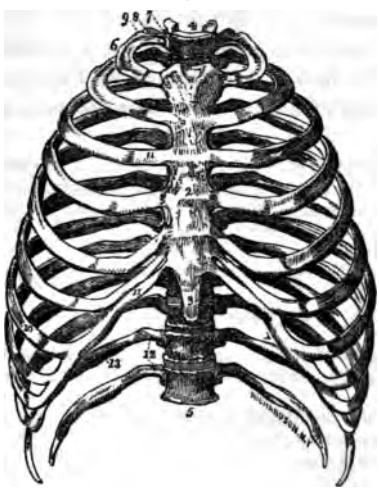
82. *When the bones are broken or injured*, a long time is usually required for their recovery, the time being necessarily longer, the older the person is. To produce a cure the part should be kept very quiet.

[Usually the pain is fortunately such that the person feels no inclination to move. If pain be not the result of movement, the injury will probably be longer in recovering.]

Sec. 2.—*The Cartilages.*

83. *Cartilage*, is what is usually termed gristle.

Fig. 18.



It differs in its composition in different parts of the body.—When it covers the bones at the joints, it is usually very firm, almost as much so as the bones, and is then beautifully finished, giving the joint a peculiarly attractive appearance. It extends from the ends of the bony parts of the ribs, to the breast-bone. See 11, fig. 18.—Here it has greater elasticity or springiness—nearly as much as in the ear or nose.

84. *By far the most important cartilages*, are those which assist in forming the back, and are of essential utility in producing and preserving erectness of form and flexibility of the back, consequently gracefulness of motion.

use of the marble? *Inf. a.*? *Inf. b.*? *Inf. c.*? *Es. a.*? *Es. b.*? †81. Are the

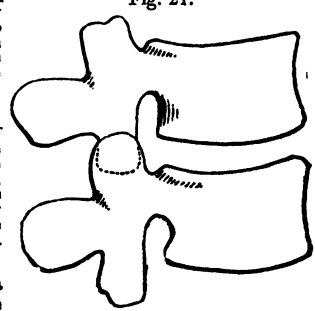
[To understand the cartilages of the back, we must also consider the bones of the back.]

Fig. 19.

At the bottom of the back-bone, and between the hip-bones, there is a curiously shaped bone, called the sacrum—*d. e.* fig. 19. Above this rises a pile of 24 bones called vertebræ, forming with cartilages a column of most perfectly adapted form, and the most exquisite workmanship. On the very summit the head is mounted. The different bones differ in several particulars, but agree in these. The front part of each, especially in the loins, is large, and called the body of the bone. Fig. 20: Back of the body is a nearly or quite perpendicular hole, the sides and back of which are not very thick. From these, branches (as they appear) project back, to the sides, and up and down. Those projecting up, are jointed or articulated to those which thrust themselves down from the bone above, as will be understood by fig. 21. Upon these joints the bones move forward or backward (see fig. 21 & 23), or from side to side. But when the bones are put together at the joints, and the back is raised into its natural position, it is seen by fig. 21, that the bodies of the bones do not touch each other. But how can they remain so when their own weight, and besides that, the weight of the head and all the upper parts of the body tend to press the back forward? A piece of cartilage fills the space between the bodies of the bones, and thus supports their weight, and any additional weight we may carry—See fig. 22.

Fig. 20.

Fig. 21.



Inf.—That a person may be erect and well formed, it is necessary that the cartilage be of proper thickness and resistance; see fig. 22.

[The cartilage may be compared to a piece of india-rubber, though much firmer.]

85. *The uses of the intervertebral cartil-*

ages are, 1st. By yielding, to allow the bodies of the bones to

Fig. 22.

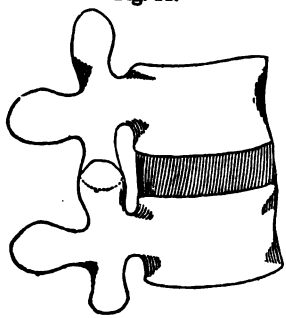
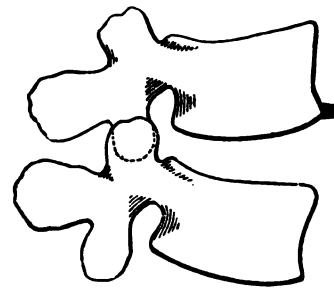


Fig. 23.



approach each other, fig. 24, by which means the whole back, or any part of the back, may be bent forward, or to one side, as the case may be. 2d. By their elasticity, to assist in raising the back to an upright position. 3d. To sustain the back in its proper position. 4th. By yielding, to allow a

Fig. 24.

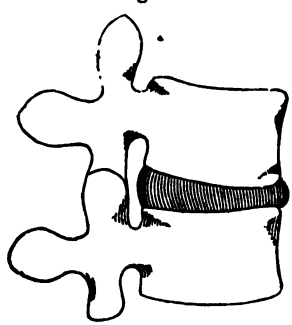
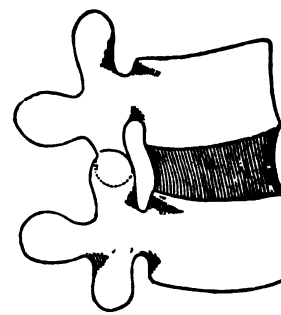


Fig. 25.

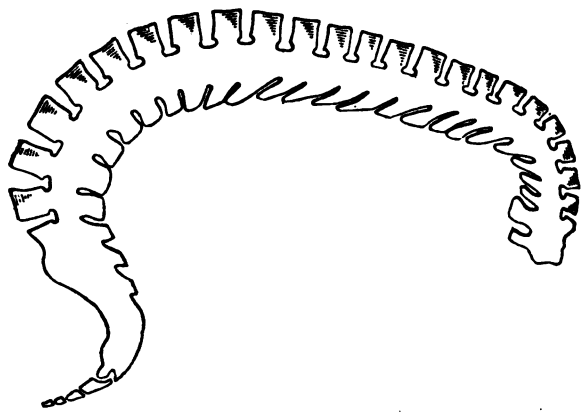


person to bend backward or to one side, fig. 26, or if de-

bones injured? *Inf.* ? ¶ 82. Do the bones heal readily? Is pain useful? ¶ 83. Common name of cartilage? Where are the most important cartilages to be found? Describe the back-bone? Are the joints upon which the vertebræ turn back or front of the centre? Is the most of the weight forward or backward of the joints? What prevents the bones from falling forward? That a person may be erect

sirable, a smaller portion to be bent. 5th. By elasticity to assist in re-bringing the back to an upright position when it has been bent backward.

Fig. 26.



86. *At different times the capability of the cartilages* to do their duty will very much differ, depending—1st. On the constitution. 2d. On the age. 3d. On the rapidity of growth. 4th. On the health. 5th. On the treatment to which they are subject.

[1st. It is scarcely possible for some persons to become crooked, the cartilage is so resisting to pressure or any other harmful cause, to which it is exposed. 2d. In infancy the back is necessarily curved, and in some cases this curvature continues longer than in others. Also in old age, more or less curvature is generally seen. 3d. When a young person grows tall rapidly, the firmness and resisting properties of the cartilage cannot, for certain good reasons, keep pace, and such persons must and ought to lean forward more or less. 4th. When persons are recovering from sickness, and first sit up, we observe that they lean forward, the

what is necessary? To what may the cartilage be compared? ¶ 85. What are the uses of the invertebral substance? ¶ 86. When do the cartilages differ? Why cannot some persons become crooked? What is the condition of the cartilages in infancy? If a person grow tall rapidly what is the result? When recovering from sickness what is

cartilages cannot and ought not, to perfectly resist the pressure. 5th. It is found that a person is shorter at night than in the morning—sometimes from half to a whole inch. This is not owing to the back-bone being any shorter, if measured through the joint, but to the fact, that during the day the pressure made upon the cartilages causes them to become a little thinner, and the back leans forward by just so much, and hence the horizontal stature of a person is diminished to a corresponding degree. It is also found, that during the night, the stature is regained, evidently owing to the want of pressure on the cartilages, by which they have had opportunity to become thick.

Inf.—It therefore follows that constant pressure tends to make the cartilages thinner, and cause corresponding deformity.

[But one other thing is to be observed, viz., that after a very long repose the cartilages are weak; also, in case of those who never carry any burdens, the cartilages are apt to yield, while in case of those who carry heavy burdens, on the shoulders or head, the cartilages improve.]

Inf. a.—The true doctrine then in regard to the cartilages is, that they should enjoy, at frequent intervals, alternate pressure and repose.

Inf. b.—Any single position, preserved for too great a length of time, must cause deformity.

Inf. c.—An abundance of exercise, at proper times, is the true way to produce and preserve a good form—the essential thing to prevent deformity.

Inf. d.—Tightly fitting dresses must keep the back in one position, and thus produce deformity.

Inf. e.—Any supports in the dress, must make a person crooked.

Inf. f.—Wearing the clothing suspended about the waist, will tend to make a person round-shouldered and crooked.

Inf. g.—If a person have compressed the cartilages for a length of time, and caused deformity (fig. 27), he must take those exercises which tend to open the cartilages and make them thicker.

Sec. III.—*Ligaments.*

87. *The Ligaments are* those strong pearl-colored parts found about the joints, and which, at the same time, bind the parts of the framework together, and at the same time allow the proper motions.

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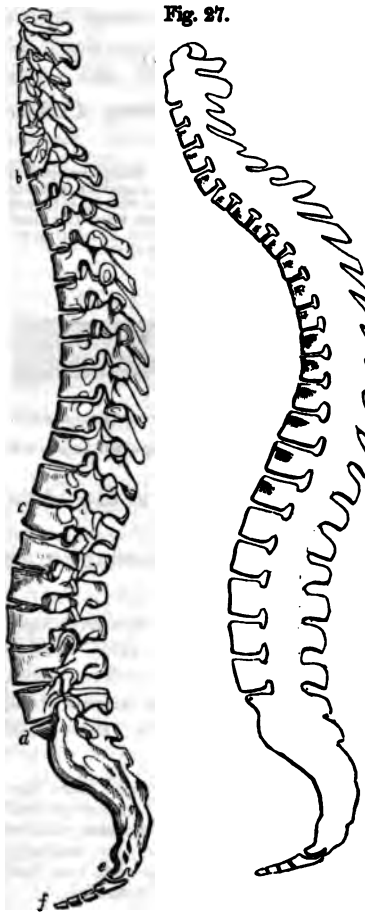
the state of the cartilages? Is a person shorter at night? Why? Why is the stature regained during the night? *Inf.*? What also is to be observed? *Inf. a.*? *Inf. b.*? *Inf. c.*? *Inf. d.*? *Inf. e. Inf. f.*? *Inf. g.*? What are ligaments? Of what are the muscles composed? How are these threads shaped? *Illus. a.*? *Illus. b.*? ¶ 88.

Fig. 27.



[Sometimes by peculiar force the bones are separated at the joints; when this is the case, they should be replaced as soon as possible, and time allowed for recovery. Sometimes also the ligaments are sprained or wrenched. Time and patience alone are almost the only cures. If too warm, the part should be cooled, if too cool, it should be warmed; nothing more is of any use except in very rare cases.]

Fig. 28.

CHAPTER II.

Motory Apparatus—Muscles, Tendons, Bursæ, Cellular Tissue, Fat, etc.

The muscles are most beautifully adapted to their purpose, being composed of fleshy strings—any one of which is smaller than the thread of a spider's web—but thousands or millions of them loosely bound together form a bundle, varying in its form according to its adaption.—See fig. 1, Pl. 1. They are sometimes formed into rings (fig. 28), which again are sometimes placed by the side of each other, and thus form a tube, fig. 29. Again, they are so arranged as to form a pouch or bag, etc.

Fig. 28.

Fig. 29.

Illus. a.—Any piece of lean meat will exhibit the fact that it is composed of strings, but more particularly a piece of lean salt pork, or a piece of fish.

Illus. b.—The stomach of any animal, especially a piece of tripe, will exhibit how the muscular strings form a pouch.

88. *The use of the muscles is* to produce motion of the parts to which they are attached.

89. *They accomplish their duty* by contracting in the direction in which their fibres extend.

[The muscles must of course be very numerous, and curiously shaped and arranged, as is seen by fig. 1, Pl. 1. Those which extend directly between two parts, as in case of fig. 17, will produce a direct motion. Those which radiate from one point to several, will cause various motions, according as this part or that of the muscle contracts. Those which encircle any opening, will by contracting close it, etc.]

Inf.—The importance of the muscles must be very great, since they produce every motion of labor or recreation—of facial, vocal, or gestural expression—and the structure, and the mode of perfecting them must be interesting to every individual, young or old, the farmer, the mechanic, the merchant, the orator, the man of leisure, and not more to man than to every lady, who would be either healthful, useful, or beautiful.

90. *The facility with which the muscles fulfil their duties,*

What is the use of the muscles? ¶ 89. How do they accomplish their duty? What kind of motion will any muscle produce? *Inf.*? ¶ 90. Upon what does the facility with which the muscle contracts depend? Is the muscle stronger during life?

depend upon—1st. Their constitution. 2d. Their health 3d. Their size and firmness. 4th. Their position and arrangement. 5th. Their *exercise*.

[1st. It would not seem as if a piece of flesh were a very strong substance. It is not after death. But during life it has most wonderful strength. Upon what particular quality this depends we do not know. It seems, however, to vary in different persons. 2d. It is evident that the health of a muscle would affect its power. 3d The larger and firmer the muscle, of course the more substance there is composing it, and the stronger will it be. 4th. The position of a muscle is frequently such, that it acts at great disadvantage in respect to power, but with great advantage in respect to producing rapid motion.]

Illus. a.—When a person places his hand near the hinge of a gate, much power is required to shut it, but it is quickly moved if sufficient power be applied.

Ill. b.—In fig. 17, the muscle B must contract with immense power to raise the weight in the hand.

[Sometimes, however, the muscles are so placed as to act with the greatest advantage—being placed between or beneath other muscles or their tendons (fig. 1, Pl. 1), or their tendons turn in such a manner as to give a new and advantageous direction to their motive power.]

Illus.—When the muscles are pressed by a strap wound round the arm or round the body, the muscles can exert a greater force than they otherwise could.

[But it is not best they should, and very bad results have been produced by laboring men tying a handkerchief round them when going to work. Indeed no part of the clothing ought to bind any muscles if we would have them remain perfect.

Exercise of the muscles is the most important thing for us to notice, as by proper exercise we can surprisingly improve the power, rapidity, and the combined or distinct action of the muscles and their various parts.]

Illus. a.—By proper muscular exercise the laborer is able to make astonishing exertions with ease.

Does the health of a muscle affect its power? How? Does the size of a muscle affect its power? What effect does the position of a muscle have? *Illus. a.*? *Illus. b.*? How are the muscles sometimes placed? *Illus.*? Is it best to tie a bandage about any of the muscles? What is the most important thing for us to

Illus. b.—By proper muscular exercise the race-horse is trained to his graceful speed.

Illus. c.—By proper muscular exercise the at first awkward movements of the musician's fingers become so easy that they seem a second nature.

Illus. d.—By proper muscular exercise the tones of the voice become clear and distinct.

[What proper exercise is, and how to produce it, will be better seen by and by, as will also many other things of great interest and utility in respect to the muscles.

Sec. II.—*The Tendons.*

The tendons are sometimes round, sometimes flat, short or long, as the case may be. See fig. 1, Pl. 1. Sometimes they connect muscles with the parts acted upon, and sometimes they are found acting as bands or loops to confine other tendons in their place as 85, fig. 1, Pl. 1. They are exceedingly strong, and much better adapted to attach the muscles to the bones than the muscular substance itself; besides, they can be condensed into a small cord and yet be exceedingly strong, and thus gracefulness of form is combined with great strength.

Addenda.—*Cellular Tissue, Bursæ, Fat, &c.*

As the muscles must lie and move upon each other, it is very proper that they should be loosely bound together, and at the same time separated, as they are, by what is called cellular tissue; as its name indicates, it is composed of cells. The sides are very delicate. They communicate with each other, and are moistened with a larger or smaller amount of fluid. This substance exists between, within, and around all the muscles, and allows them to move upon each other without producing the effects of friction. At certain points where the tendons or other parts are subject to extraordinary pressure, a strong bag filled with fluid, and called a bursa, is placed. It is sometimes only as large as a pea. It is not however filled out plumply like a pea, except in case of disease. Many otherwise vacant spaces are filled with fat, which, during life, is a kind of semifluid, found in clusters of little sacs. Its uses will be hereafter shown.

CHAPTER III.

Motory Nerves.

[As we do not know upon what particular property the power of contraction in the muscle depends, we cannot tell what particular cause is necessary to make it contract. One thing is evident, however, the muscle is not powerfully contracted all the time, but instantly becomes so when the mind wishes it. The mind, therefore, has the ability to cause the muscle to contract. There must be communication between

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notice? *Illus. a.*? *Illus. b.*? *Illus. c.*? *Illus. d.*? Describe the tendons? Describe the cellular tissue? The bursæ? The fat? What has the ability to cause

the brain and muscle, in order that the mind may exert an influence upon the muscle. If we examine, we shall find that certain nerves are the only means which exist; and that they are the means, is proved by cutting across them, when the mind no longer is able to exert an influence upon certain muscles. How the influence is exerted through them we cannot tell. One thing is certain, the influence does not act through the side of the nerve, but only on the muscle at its outer extremity.

Illus.—Almost any nerve lies upon or is situated in muscles between the brain and its place of termination, but those muscles are not ever affected by it.

Inf.—The influence exerted is not at all like electricity, magnetism, etc.

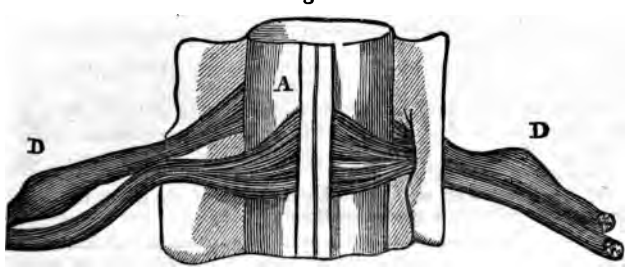
[How the ends of the nerve terminate in the muscle we no more know than we do how they commence in the brain. One thing is certain,—]

91. *There are* certain nerves through which the mind can cause the muscles to contract.

92. *The mind has the power of* causing an influence to be exerted through any one or several nerves, according to the motion desired.

93. *The influence exerted is called* nervous, because it is produced by means of the nervous system.

Fig. 30.



the muscle to contract? Through which part of the nerve is the influence of the nerve exerted upon the muscle? *Illus.*? *Inf.*? ¶ 91. By what means can the mind cause the muscles to contract? ¶ 92. Can the mind exert an influence through any nerve?

94. *The nervous influence* when exerted, no matter what causes it to be so, will at once compel the muscle to contract.

The nerves through which the muscles are caused to contract, are not in fact the same as those through which sensations are produced. They appear to be so outside the spinal column, but inside it, and near to the spinal cord, there are two what are called roots of the nerve. The anterior (front) and posterior (back). See fig. 30.

Exp.—If the front root be cut, certain muscles cannot be contracted. If the back one be cut, feeling cannot be produced in that part where the nerves commence.

95. Almost every nerve existing between the muscles and brain may be considered as composed of two kinds, one commencing in the brain and terminating in the muscle, and called motory. One commencing in the muscle and terminating in the brain; called sensory.

CHAPTER III.

The Brain as a means of producing Motion.

[How the brain assists in producing motion is not known. However it acts, in voluntary motion its action is caused by the mind.]

96. *The mind* is the first cause of all voluntary motion.

97. *The action of the mind* in producing motion is of two classes—intellectual and emotional.

Illus. a.—We may by our voice merely convey an idea, but by the tone of voice, by gesture, by expression, we signify what we think of it, how it had affected us.

Illus. b.—If a boy be asked to shout John, or any other word, he does it, but is soon hoarse and tired. It is done intellectually merely. But tell him to shout to another boy and request a ride, and he will do it with energy many a time, and feel no fatigue. His emotions are active.

Inf. a.—If we wish to produce motions easily, we must have our emotions active and lively.

Inf. b.—If we wish an animated expression of the countenance or eye, we must cultivate a good disposition.

¶ 93. What is the influence called? ¶ 94. What effect will the nervous influence have upon the muscle? Describe the motory nerves? ¶ 95. Of what may almost every nerve be considered? By what is the action of the brain caused? ¶ 96. What is the first cause of voluntary motion? ¶ 97. What are the classes of mental action? *Illus. a.*? *Illus. b.*? *Inf. a.*? *Inf. b.*? *Inf. c.*? *Inf. d.*? *Inf. e.*? ¶ 98. When select-

Inf. c.—If we wish a pleasant tone of voice, we must cultivate a good disposition.*

Inf. d.—If we wish to exhibit urbane manners, we must cultivate a good disposition.

Inf. e.—In short, if we wish to be either attractive by our beauty and gracefulness, influential with our customers or neighbors, or useful to ourselves by the labor of our hands, we must cultivate a lively and good disposition—all those traits that adorn both man and woman, and thus give a zest to the action of the muscles, which shall cause them to do all and every thing desired of them without fatigue.

[A prosy walk, or any exercise of the muscles, is better than none; but exercise should be our desire, not intellectually merely, but emotionally. After a time, the system of course will be exhausted, but for a long time will speaking or any other exercise be done with ease if the heart is only in it.]

98. *When selecting any avocation for life*, we should choose one in the pursuit of which a lively state of the good emotions will be caused, as then the action necessary will be easily performed.

99. *When choosing any kind of exercise*, that will be the best and easiest which is caused by a lively state of the disposition.

[There are many points of importance in the management of the organs thus far discussed, in addition to those already mentioned. They will be exhibited in the following portions of the work, when the why and wherefore can be given and easily understood.]

* Hence a man with a good disposition will fatten his animals, or keep them on less food than the cross and surly person.

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ing any avocation for life what should we regard? ¶ 99. What exercise should we choose?

PART II.

THE MEANS BY WHICH THE BODY IS KEPT IN A PROPER CONDITION FOR THE MIND TO FEEL, THINK, AND ACT WITH.

DIVISION I.

THE MEANS BY WHICH THE BODY IS KEPT IN A PROPER STATE OF REPAIR.

BOOK I.

EXCRETION, THE MEANS BY WHICH THE PARTS OF THE BODY, AS THEY BECOME USELESS, ARE CARRIED OUT OF IT.

[If we look into the organs we have thus far discussed, and observe what is taking place, we shall observe that,]

100. *When the various organs of the body are used*, some of the atoms of which they are composed are undergoing a change, and in their new forms become useless in those parts wherein they were produced.

Illus.—When a muscle contracts, some of its atoms become changed so as no longer to be muscle, any more than smoke, gas, and ashes, are like the wood from which they were formed.

[So also in case of the brain, or any other part, though the changes in the different parts take place with very different degrees of activity.]

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† One result of using the organs? *Illus.*? Are the changes in all parts similar?

101. *These changes are necessary* to the action of the organ, where they take place, as the change of wood to the production of heat.

[As also it is necessary that the ashes, gas, and smoke, be carried off in case of burning wood, so]

102. *The useless substance resulting* from the action of the muscle or other part, must be removed as speedily as it is produced.

[For this purpose nothing could be better adapted than a set of tubes commencing in all parts of the body, and having constantly a current of fluid moving through them. If then the useless particles from any part, should be caused to pass into the current, they must be carried away by it. Such a set of tubes are.]

CHAPTER I.

The Veins.

The veins are fleshy tubes, commencing in or near almost every part of the body as large as the point of a needle. As the drops of rain unite to form rivulets, which uniting form brooks, by the confluence of which the noblest rivers are produced—so do the veins, at first too small to be seen by the naked eye, unite to form larger ones, till at last those are formed, which we so distinctly see on the back of the hand or elsewhere. They commence within the body as well as near its surface, and with one exception they all empty into the right heart, as represented by fig. 1, Pl. 3. Those from the upper part of the body, unite and form one great vein which opens downward. Those from the lower part of the body, with one exception, unite to form one great vein which opens upward.

103. *The substance which passes into the veins* undergoes no change while there.

Inf. a.—The veins are merely a set of tubes, to allow the useless substance to pass from all parts of the body, where it has been produced, to the right heart.

Inf. b.—There must be a constant current of fluid flowing into the small extremities of the veins, and through them into the heart.

104. *One of the uses of water*, is to act as a vehicle to bring useless substance from all parts to the heart.

¶ 101. Are the changes important? Will any heat be produced while the wood remains as wood in the stove? ¶ 102. What must be done with the useless substance? What would be adapted to such a purpose? Describe the veins? ¶ 183. Is the substance in the veins changed? *Inf. a?* *Inf. b?* ¶ 104. One of the uses of water? Do

Inf.—That the process of excretion may take place perfectly, it is very important that water be used in proper quantities. It is important to the student, the laborer, and to all who would have the action of their organs healthful and lively, and thereby productive of pleasant sensations.

[The veins should of course be so constructed that their contents cannot be pressed back into the parts from which they came, as would be the tendency from the pressure to which the various parts of our bodies are subject.]

Fig. 31.

The valves of the veins are so attached (fig. 31) to one side of the vein, that they will allow the blood to flow *toward* the heart. If it attempt to flow *back*, it spreads the valve out across the vein, and thus obstructs its own course, and causes those little "bunches" seen after pressing the veins on the back of the hand.

105. *On account of the valves of the veins*, the rubbing of any part will cause the blood to flow more rapidly toward the heart. On the same account the contraction of the muscles will have the same tendency in respect to those veins in their vicinity, upon which, by contraction, they produce pressure.

If constant pressure be made on the veins, the flow of blood through them, instead of being accelerated, will be retarded or altogether stopped.

Inf.—Tight clothing or any bandages, must be very injurious.

CHAPTER II.

Right Heart.

That which is commonly called the heart is a piece of dense lean meat or muscle, having in it certain holes or cavities, lined with a beautifully delicate membrane. It might also be called a hollow muscle or muscular pouch, having very thick strong sides. It is about the size of a clenched hand, is heart-shaped, and situated directly back of the breast-bone, its small extremity projecting a little to the left of it, 5 4, fig. 32.

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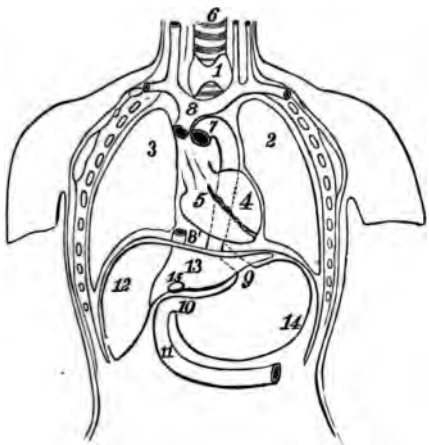
people usually, when they use water, think what they are using it for? How then shall a person know how much to use? To whom is a knowledge of the uses of water important? Why? How should the veins be constructed? Describe the valves? ¶ 105. What effect has rubbing? When will rubbing be beneficial? What effect has

Fig. 32.



It is surrounded by the heart-case, and suspended in its place by attachments called roots, passing from its upper part to the back-bone By examining it, we shall observe that it can be divided perpendicularly, in two halves, called, very properly, two hearts. Each of these is entire by itself and composed of two parts. The upper is called an auricle. It has comparatively thin sides and is the one into which the veins open. The lower part is called a ventricle, into which the auricle pours its contents, through an opening, about which valves are so arranged as to allow the blood to pass into the ventricle, but not back again. From the upper part of the ventricle is an opening into a tube; about this opening are valves so arranged as to allow the blood to pass out from the ventricle but not back into it. **Fig. 32**, represents the right heart; *s vs* the large veins, formed from all those of the lower parts. *s v*. from all those of the upper parts. *a* auricle. *v v*, ventricle. PA, tube called lung or pulmonary artery. T *v*, place of valves. S *l v*, place of valves, of the action of which fig. 34 gives a fanciful representation. There is not a *correct* form of parts given in all cases.

Fig. 33.

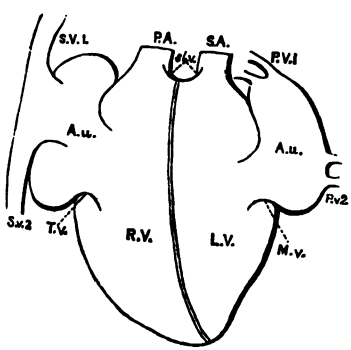
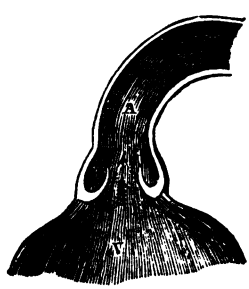


Fig. 34.



106. *The use of the right heart*, is to receive the blood gathered by the veins, and by contractions pour it into and through the lung arteries.

Illus.—If a bladder be filled with fluid, and we grasp it suddenly with the hand, the contents will be thrown out with a jerk or spirt.

[So it is in case of the heart. Its lining may be considered as a bag or bladder, about the sides of which are thousands of muscular fibres, entirely covering it, and acting like so many delicate and closely placed fingers.]

107. *The frequency with which the heart should contract*, will depend on a great variety of circumstances. The average is about 75 times per minute, in case of men; about 80, in case of women.

[If we compute the labor of the heart, as discharging but one ounce of blood at a contraction, and suppose that there are only 64 per minute, the result will be—4 lbs. per minute, 240 lbs. per hour, 5,760 lbs. (nearly 3 tons!) in a day and night. Or if we say a pound of blood measures a pint, it will amount to more than a barrel in an hour. Astonishing! But this is not the half if the truth were told. What is all this for? Let us follow it and see. In the lung artery we find it dividing into two currents, following one of which we find, in a few inches, it divides and subdivides, the divisions growing smaller and smaller, till finally they terminate in a net-work of tubes smaller than hairs, and so near each other that the meshes are not as large as the diameters of the tubes or vessels. From their minuteness, they are called capillary (hair-like) vessels. Upon examination, this net-work will be found upon the sides of what are termed air-cells.]

Illus.—Suppose soap-bubbles scarcely as large as the smallest mustard seed, and on the sides of these the beautiful net-work just described.

[While watching the blood in its passage through this net-work, (see net-work upon a single cell, exceedingly magnified, fig. 3, Pl. 3) we shall

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muscular exercise? Effect of constant pressure? Why? *Inf.*? Describe the right heart? ¶ 106. Use of right heart? *Illus.*? How may the heart be considered? ¶ 107. How often should the heart contract? How much labor does the heart perform? Have you counted the pulsations of the heart? Have you computed its labor on your slate? If we compute the beats as 75, and the capacity of the heart as 3 ounces, what will the result be? To where does the blood go from the heart? Describe the capillary vessels? *Illus.*? What is observed to take place as the blood

observe it passing through various changes. First, its change of color—when it came from all parts of the body, and while in the veins, right heart, and the lung artery, it was of a very dark red—sometimes called purple or even black.]

Illus.—This then is what gives color to the veins beneath the skin.

[While passing through the net-work, it changes to a bright vermilion. Second, if more particularly examined, we find that certain substances leave it and pass into the air contained in the air-cells.]

Exp.—If we have a jar with an open bottom, and place it horizontally in a pail of water, we can apply the mouth to the nose of the jar and suck all the air out, till the water rises to the mouth; we can then blow the air back again, and fill the jar with air which has been acted on by the blood in the lungs, and receive some of the substance which has been discharged from the blood into it. If, when we take away the mouth, we quickly place a lighted candle or match into the bottle, the flame will be at once extinguished.

108. *The object to be gained by the action of the right heart is* to have the blood returned through the veins, subject to the action of the air.

Inf.—The quantity of blood thrown out is so great, a very large quantity of air would be supposed necessary.

109. *The importance of the air may be judged of,* from the immense quantity of blood subjected to it, as well as by the important fact that, if a person be plunged beneath the water from two to five minutes, he will die.

[He dies, because he cannot receive air, to extract from the blood the substance which accumulates so rapidly, that in this short space of time, it acts as a deadly poison. As it is naturally produced and must constantly exist in the system in small quantities, it is not poisonous until the instant it accumulates beyond the necessary and natural amount. What is desirable, therefore, is, that by some means a constant supply of pure air shall be brought into contact with this constant flow of blood. How admirably this is accomplished we will now observe.]

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passes through the capillaries? What color do the veins beneath the skin appear to be? What is the *Exp.*? Have you tried it? ¶ 108. Object to be gained by the right heart? What should we judge of the quantity of air required? ¶ 109. How may the importance of air be judged of? Why does the drowning person die? Is a small

CHAPTER III.

The Lungs and Breathing Apparatus.

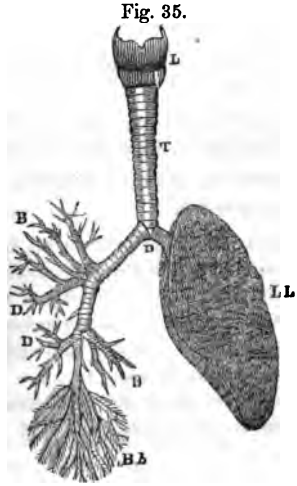
110. *The means by which the blood and air act upon other*, may be considered under three heads. 1st. Those which the blood is brought to and carried from the air. Those by which the air is brought to and carried from blood. 3d. The process which takes place as the blood a air act upon each other.

[It will be best to vary somewhat from the order here mentioned.

SEC. I.—*The Lungs.*

The windpipe commences just beneath the back part of the tongue, where is a par called the epiglottis, of a cartilaginous character, shaped somewhat like a slender leaf. It is hinged to the front and upper part of the windpipe, which is raised when we swallow and thus closes itself. The upper part of the windpipe, which feels so large, is composed of several parts, arranged for the purpose of speech. The opening through these parts is very much narrower than in the windpipe lower down. From this part, called the Larynx, or *Adam's apple*, commences a series of cartilages, in the form of four-fifths of rings, the other fifth being closed with what is called yellow ligament, which also connects the rings with each other. Thus an entire tube is formed which extends down as far as back of the upper part of the breast-bone, where it bifurcates, a branch passing to each side, as seen in fig. 35. Following one of them, we soon see it dividing and subdividing, till at last the tubes are scarcely larger than hairs.

Fig. 35.



L, Larynx. T, Trachea. D, Bronchii. L L, Left lung.

[Some suppose that in the sides of the smaller tubes, at least, a certain amount of muscular substance will be found, by the contraction of which the tubes will be lessened in size.]

The mucous membrane of the air-passages, is a skin lining the nose, throat, and windpipe, and at extremities of the windpipe formed into the delicate air-cells, before mentioned. It is constantly lubricated by a glary substance, much like the white of an egg, but in health not so viscid.

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amount of useless substance poisonous? What is desirable? ¶ 110. Under how many heads may the means by which the blood and air act upon each other, be

111. *The receptacles of the air are* therefore composed of two classes of parts. 1st. The framework of tubes, the use of which is to allow the free passage of air through them, and assist in producing speech. 2d. The mucous membrane lining the pipes, and forming in the most delicate manner the air-cells.

Inf.—As the air acts through the sides of the air-cells on the blood, it is important that their inner surfaces be not thickly covered by any viscid substance, or things which will obstruct the free passage of the air.

[When a person has taken cold, and at various other times in case of disease, there is so much substance covering the inner surface of the air-passages, that the air does not act effectually.]

112. *The reason for the arrangement described is*, that there may be a great extent of surface, and therefore a great quantity of blood presented to the action of the air, in a small space.

[One author has computed no less than 180 millions of air-cells in a single pair of lungs, and thus there is a greater amount of surface in the lungs than on the entire outer surface of the body.]

The blood-vessels through which the blood reaches the air-cells, as already described, commence at the right heart and pass directly to the two divisions of the windpipe, and following it divide as often as it divides, thus reaching the net-work of every air-cell. See fig. 2, Pl. 3. After the blood has passed into the net-work, it flows through a set of veins which follow back by the side of the windpipe. Of these there are at least two. Therefore, if the windpipe be cut across, three blood-vessels will also be cut, one through which the blood is passing to the net-work, and two through which it passes from the net-work.

113. *There are three kinds of blood-vessels* through which the blood visits and returns from the air. 1st. The arteries. 2d. The capillaries 3d. The veins of the lungs.

[Though the parts already described are so numerous, there are millions of each, and it would seem as if the whole would make a compact mass.]

114. *There are yet almost innumerable small spaces* filled

considered? Describe the windpipe? Is there any muscular substance in the sides of the windpipe? What is the mucous membrane? ¶ 111. How are the receptacles of the air composed? *Inf.*? ¶ 112. What is the reason for the arrangement in the lungs? Describe the blood-vessels? ¶ 113. How many kinds of blood-vessels are

with a delicate substance, "the substance of the lungs" or the parenchyma of the lung, etc.

The precise use of this is not known. It appears to possess a high degree of useful elasticity; that is, if it be compressed, or spread, it resists to a degree, and springs back to its natural condition when the force is removed.

Exp.—Obtain a pair of uncut lights or lungs of an animal, with a piece of the windpipe attached. With a tube, blow into the pipe and fill all the air-cells, and the lungs will be enlarged and appear beautifully. As soon as the mouth is taken from the pipe the lungs contract instantly, and with considerable force expel the air.

[Whether the force is entirely dependent on the elasticity of the parenchyma or on the action of the muscular fibres, which are thought by some to exist in the smaller divisions of the windpipe, is not certain. This, however, is true:]

115. *The lungs have the power of expelling* the air, if no overpowering force retain it in them.

[I shall call this power the *contractile power* of the lungs.]

[To complete the lungs, three things more are necessary. 1st. A set of blood-vessels for removing all useless substance and nourishing the lung. 2d. Nerves through which influences act from and to the lung. 3d. A covering for all these parts—this is called the pleura (lung pleura), and forms the beautifully delicate external of the lung. Besides these, are found some cellular tissues, and certain tubes or vessels, called lymphatics, the use of which is not positively known.]

116. *The lungs are composed of nine classes of parts.* 1st. The cartilages, yellow ligaments, and perhaps the muscular substance of the windpipe. 2d. The mucous membrane. 3d. A set of three kind of blood-vessels. 4th. The parenchymatous substance. 5th. A second set of three kinds of blood-vessels. 6th. Nerves. 7th. Cellular tissue.

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there through which the blood flows in the lungs? What and where is the parenchymatous substance? What exp. is mentioned? Have you tried it? Who will obtain and prepare and bring a pair of lungs (calves will be too firm) at next lesson? ¶ 115. Will the power of the lungs expel the air? What will the author call this power?

8th. Lymphatics. 9th. The pleura. See 1 and 2, fig. 1, Pl. 3, and 1 2, fig. 28.

[We now desire an arrangement, by which air can go into and out of the air-cells in large quantities.]

Sec. II.—*Breathing Apparatus.*

[In order to have the lungs filled with air, it is necessary that they be placed in a box, in which there is no opening, except for the windpipe and blood-vessels of the lung, and those must perfectly fill the opening. If the box be enlarged in all directions, and if the top of the windpipe be opened, the air must press in and cause it to be filled, unless the contractile power of the lung is greater than the inward pressure of the air. If, again, the box be smaller, the contractile power of the lung will expel the air from it, or the pressure of the sides of the box on the lung will accomplish the same. Ordinarily, however, as the windpipe is open, the power of the lung will act so quickly that the sides of the box can not touch the lung itself. Perhaps by figures this can be better understood. Let 15 represent the pressure of the air upon the inside, and 15 the pressure on the outside of the lung; 10 represents the contractile power. This 10 acts with the 15, outward pressure, making in all 25 to overcome the 15, inward pressure. As soon as the lungs are in the air-tight box, and the box begins to enlarge, we begin to take off the external pressure, leaving only 10 to contend with 15, inward pressure, which of course overcomes and forces the lung outward, and towards that part of the box which is enlarging. As soon as the box begins to contract, the outward pressure is added to the 10, and 25 will again overcome the 15, inward pressure. If, by nervous influences, the 10 could be diminished each time the box is enlarged, and increased when the box contracts, the process of filling and emptying the lungs would take place more easily.]

117. *The apparatus by which the air is caused to pass into and out* of the lungs, consists, 1st, of the two boxes, in

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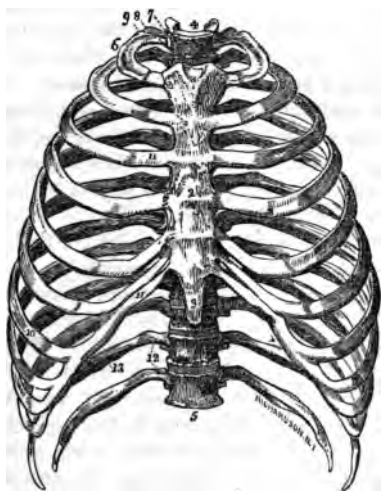
Upon what part of the lungs does it depend? To complete the lungs what more is necessary? Does it seem as if there could be any more parts in so small a space? ¶ 116. Of how many parts are the lungs composed? To have the lungs filled, where must they be placed? If the box be enlarged what must result? If the box be made smaller what? Is the windpipe usually open? When is it closed? With the black board will you show what the author means by the numbers he has used to represent his ideas? If by nervous influences the contractive power could be increased and diminished, what would be the result? ¶ 117. Of what does the breathing apparatus

each of which is placed a lung; and secondly, of a mus arrangement, by which the boxes can be enlarged diminished.

118. *The boxes are composed of a framework and li*

119. The framework is composed of back-bone, the and their cartilages, and the breast-bone.

Fig. 36.



The 12 vertebræ, below the neck, form t tral back part of the che these, twelve ribs are a on each side, curving and downward at th time. To their front extu strips of cartilage are a which either connect th rectly with the breast-b with the cartilage of t above. The lowest two have no cartilages, a called floating. See fig. 5 represents the lower v of the chest, 2 the brea 11,11 the cartilages, 10 ribs.

120. *The use* back-bones in th cess is very impor since the carti or intervertebral stances of it exe influence in enla and diminishing frame, as must be evident.

121. *The ribs are of use in enlarging and dimini the box;* as when they come down and curve round, if are raised the chest must be made larger in every dire

Illus.—If a person place his hands upon the sides of his ches inhale a full breath, his ribs will be raised up and his chest enlarg

consist? ¶ 118. Of what are the boxes composed? ¶ 119 Of what is the fra composed? Describe the framework? ¶ 120. Use of the vertebræ of the ¶ 121. Use of ribs? *Illus.?* What will be the effect of any bandage? ¶ 122.

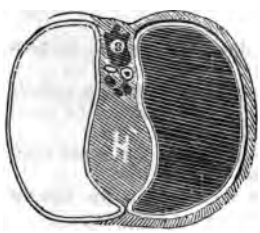
[It is not the reception of air which enlarges his chest, but the enlargement of his chest which admits the reception of the air.]

Inf.—If there be any bandage about the chest, or the clothing is tight, the ribs are not so easily raised.

122. *The cartilages are* of great use, since being elastic, when the ribs are raised up, the cartilages tend to spring them down, and when the ribs are lowered the cartilages tend to raise them again. Thus they assist both in enlarging and diminishing the chest.

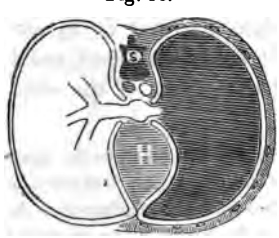
[Their peculiar form and arrangement is well worthy of note. In every respect they are most remarkably adapted to their duty.]

Fig. 37.



The lining of the ribs is called the rib pleura (pleura costalis). It stretches across from one rib to another, lying upon and adhering to the inner surface of the ribs, closing across the opening at the upper part of the chest. It then becomes attached to the back-bone, and leaving it stretches forward to the breast-bone, curving round the heart, as is shown by fig. 37 and 38. At the bottom of the chest it stretches from one side to the other, as shown by fig. 39, in a somewhat arched manner.

Fig. 38.



[Thus on each side are formed two air-tight boxes, the sides and bottom of which, and indeed we may truly say, the top and back, are movable. The heart and large blood-vessels are situated between them very securely. The windpipe leads down, and uniting to the blood-vessels, etc., which form what are called the roots of the lungs, pass through the sides of the box, perfectly closing the opening. At once, therefore, the air presses through the windpipe into the air-cells of the lungs, and fills them out till the lung completely fills the box.

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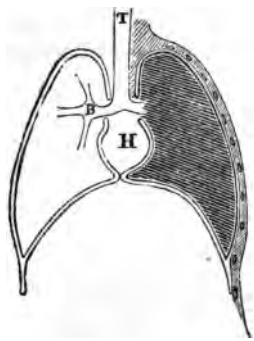
the cartilages? What is worthy of note? Describe the lining of the ribs? From where and to where does the windpipe lead? Describe the muscular apparatus which raises the ribs? Describe that very important muscle, the diaphragm? Do you suppose there is one in the sheep, hog, etc? Why? Where would you find it in those

Fig. 39.



The muscular apparatus which c
the box consists of those which stretch fi
rib to another, as seen in fig. 1, Pl. 1.
which stretch from the ribs to the bac
shoulder-blade, or head, and from the sl
blade to the back-bone or head, and esp
of a flat muscle closely attached to the
of the chest, and seeming to be a part o
with it, is called the diaphragm, or sou
the midriff. Its threads extend from th
border of the chest upward in an archir
ner toward the centre, which is chiefly
of the tendons of these threads.

123. *The use of the m*
attached to the ribs is to rais
ribs in the process of inspir

124. *The use of the*
phragm is to lengthen the
by drawing down the bottom of it.

Inf. a.—The bottom cannot be drawn down without moving
every thing below it.

Inf. b.—Since the part of the body below the diaphragm is per
filled with one organ or another, fig. 3, Pl. 3, they cannot be r
without the sides of that part of the body distend.

Illus.—If the hand be placed on the abdomen, and a full l
inspired, the sides will be noticed to distend.

Inf.—Any clothing or bandage placed tightly about the abd
must prevent its easy distention, and of course easy breathing.

The muscular apparatus by which the air is expelled consists chiefly of the n
which pass across from the lower parts of the chest over the organs of the abdo
the hip bones below, as seen in fig. 1, Pl. 1.

125. *The use of the muscles just described is*, by
tracting, to draw down the ribs which have been raised, a
the same time press in and upward the organs of the a
men.

[Thus, to increase the size of the right and left chest, as the
may be called, we have the ribs raised, or the diaphragm contract
both, as in fig. 40 and 41, and the chest rises from the continuous
dotted lines. Its bottom is depressed from the continuous to the c
lines, and as a result, the sides of the abdomen from the position c

animals? Who will try to obtain a piece of one? ¶ 123. Use of the costa
muscles? ¶ 124. Use of the diaphragm? *Inf. a?* *Inf. b.?* *Illus.?* *Inf.?*
cribe the muscular apparatus by which air is expelled? ¶ 125. Use of the n
just described? What may the boxes be termed? How may they be enlarged?

continuous take that of the dotted lines. To diminish the size of the chest we contract the sides of the abdomen, and thus depress the ribs and raise the diaphragm.]

Fig. 40.

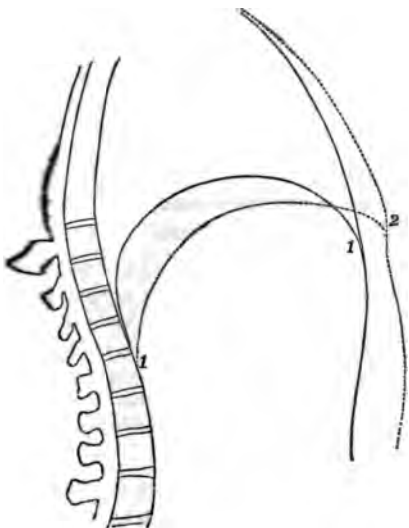
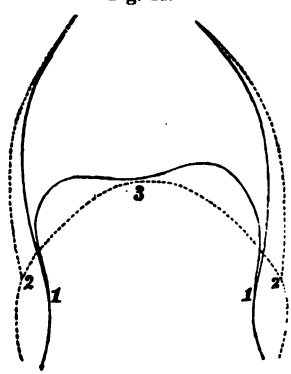


Fig. 41.



126. *In order that there may be a large quantity of air* acting on the blood in the lungs, it is necessary—1st. That the cartilages of the back be perfectly elastic and pliable. 2d. That the ribs move freely at their joints. 3d. That the cartilages which are at the front ends of the ribs be elastic and perfect. 4th. That there be nothing about the ribs to prevent their rising, nor any thing about the abdomen to prevent its distention. 5th. That by exercise the muscles be strengthened and rendered capable of their duty. 6th. That the organs of the abdomen be neither too full on one hand, nor too empty.

Inf. a.—A person should never wear tight clothing.

Inf. b.—A person should not confine himself long in any one position.

Inf. c.—A person should not be sedentary in his habits, but stir about out of doors, go up hill and down, and take such exercise as will cause forcible breathing.

Inf. d.—A person should sing, read aloud, recite, etc., every day.

SEC. III.—*The Air and its Action.*

127. *Pure air is composed* of three kinds, called oxgyen, nitrogen, and carbonic acid—(this last is composed of two things, carbon and oxygen,)—in the proportions of one-fifth, four-fifths, and one part in two thousand.

128. *The air we breathe out varies* in different cases, but there is less oxygen and more carbonic acid, and much watery vapor, containing also several ingredients.

[There are three ways of accounting for these being so—1st. It may be supposed that when the air enters the air-cells a part of its oxygen disappears by passing into the blood, and becoming part of it, while at the same time carbonic acid leaves the blood, mingles with the air, and is expelled with it. 2d. It may be supposed that a part of the oxygen unites with carbon, which leaves the blood for that purpose, and that thus carbonic acid is formed. 3d. It may be supposed that both processes take place at the same time. One thing is certain,]

129. *The air which has once been expelled from the lungs* should never be re-breathed, for two reasons—1st. It does not contain as much oxygen as is necessary to remove the impurities of the blood. 2d. It contains too much carbonic acid, which is very deadly in its effects.

[Since, without the air contains sufficient oxygen, the poison will not be prevented from accumulating in the blood, it is essential—1st. If we would enjoy those pleasant sensations which arise from a healthful condition of the internal organs, or an active state of the external organs of sensation, that we should be careful to have our rooms well ventilated.

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do we diminish the sides of the chest? Is there any direct connection between the chests? Can one be enlarged except the other be? (Yes.) Is it desirable that a large quantity of air act on the blood in the lungs? ¶ 126. How may it be caused to act? *Inf. a? Inf. b? Inf. c.? Inf. d.?* ¶ 127. Of what is air composed? ¶ 128. Are the constituents of the air we exhale always similar? What three ways are there for accounting for the difference between the air we inhale and that we exhale? ¶ 129. For what reasons should air not be re-breathed? For what is ventilation necessary?

2d. If we wish to acquire knowledge, or communicate it to others, we should have our rooms ventilated perfectly. 3d. If we desire to labor effectually we must vefitilate our rooms. 4th. If we wish to enjoy perfect repose, we must have our sleeping apartments ventilated. 5th. If we would be beautiful or animated, it is essential that at all times we should have all our rooms ventilated.]

Inf. a.—On every account it must be bad economy not to have our churches, halls, school-rooms, parlors, sitting-rooms, bed-rooms, and shops *well ventilated.*

Inf. b.—A teacher must not expect his pupils to make rapid progress; the scholar must not expect the teacher to be pleasant, lively, and faithful; an audience must not expect a speaker to be interesting, nor a speaker expect his audience to be attentive and pleased; nor can any entertainment or party prove in the highest degree satisfactory, unless pure air is constantly breathed by every individual.

[A very good way, in many cases, is to have a tube lead from out of doors under the floor, and open quite close against or under the stove, thus insuring a rush of air directly to the stove and preventing it from creeping in through every crevice, and flowing to the fire over the feet of those occupying the apartment. An opening should also exist in the upper part of a room to allow the air to pass off.]

[The value of pure air will perhaps be more highly estimated if one thing further be noticed. When a person has inhaled the air he at once begins to expel it, since the air scarcely begins to act on the blood till the lungs begin to contract on their contents. When the air has been expelled he waits a greater or less length of time before he inspires the air, for two reasons—1st. Because then the blood and air which still remains in the lungs are acting upon each other most efficiently; and 2d. That there may be time for the bad air to escape from the vicinity of his lips. This it does because being warmer than the air it rises.]

CHAPTER IV.

The Left Heart.

[If we examine the blood that comes back from the lungs, we find that it is in part composed of various useless substances, the lungs have

Inf. a.? *Inf. b.*? What is sometimes a good way to ventilate a room? When is the longer time between inspiration and expiration, or between expiration and inspiration? Why does a person wait? What found in the blood returned from the lungs? How can the remaining substances be removed? What have the lungs removed? Has

not the power to remove. They can only be removed by the action of certain curiously formed parts, each most beautifully adapted to its duty. That substance which would be most immediately deadly if accumulated in the blood, is removed by the lungs. It is not absolutely essential that all the blood now travel directly to another excreting organ. Yet, it will not be proper to have any kind of the useless substances remain in the blood long. The whole of the blood must therefore ere long be subjected to all the parts that are necessary to completely remove all useless material.]

130. *In order to have the useless material contained in the blood removed from the body*, at least three things are necessary—1st. The blood must be carried to, 2d, some organ adapted to remove it from the blood. 3d. And there must be a communication between this organ and the surface of the body.

131. *To fulfil the first condition*, the blood which comes back from or has passed through the lungs, is poured into the left heart.

The left heart is constructed almost precisely as the right one is.

132. *The use of the left heart* is to receive the blood from the lungs, and by contracting pour it out into a tube called the aorta.

CHAPTER V.

Systemic Arteries.

Systemic arteries is the name of a tube and its divisions, commencing at the left heart and leading into all parts of the body. The branches of this tube or vessel have particular names, according to the part in which they are found. See the red part of fig. 1, Pl. 3.

133. *The arteries are of use* as tubes, to allow the blood to be poured through them to the places where it is required.

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all the blood been subject to the action of the lungs? Must it all be subjected immediately to the action of the other excreting organs? What is not proper? What is said of the whole blood? ¶ 130. To have the useless material removed, what things are necessary? ¶ 131. To where does the blood come back from the lungs? How is the left heart constituted? ¶ 132. Use of the left heart? Describe the systemic arteries? Why their specific name? ¶ 133. Use of the systemic arteries? Describe

[It is uncertain whether or not the arteries are of use in forcing the blood through themselves.]

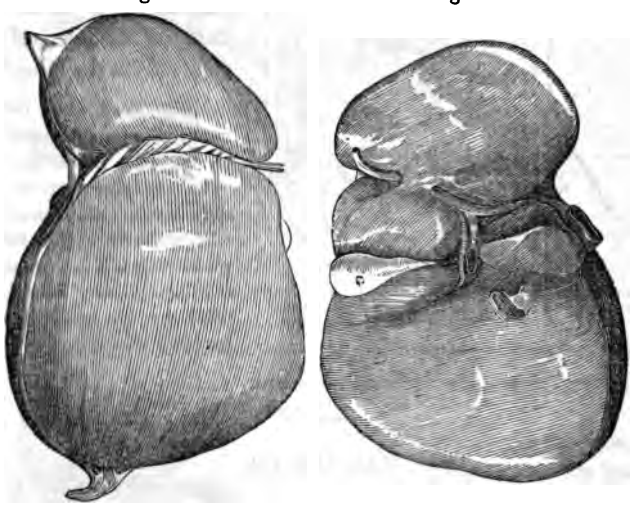
[The blood does not change while in the arteries.]

CHAPTER VI.

The Liver.

If we follow one of the branches of the great artery we shall arrive at the liver. This is very similar, in most respects, to what we should find in any animal. It is seen at 4, fig. 1, Pl. 2, in the right side, close under the diaphragm, and of course has a convex upper surface, seen from above in fig. 42. Its under surface is concave, and seen from below in fig. 43. It is thick in the centre of the right side, becoming thinner

Fig. 42. Fig. 43.



toward the left edge, which is somewhat to the left side of the centre of the body or pit of the stomach, as seen by 12 and 13, fig. 32. The shape of it is also given from front back, by fig. 44, where the body is seen as divided perpendicularly from forward back through the centre of the right side; L being the liver, beneath D the diaphragm. When the hepatic (liver) artery reaches this organ, we should find it dividing and subdividing, till we should be lost in its mazes. It is, however, by some supposed to terminate in a net-work of cells, situated on or in the sides of cells. Into these cells a greater or less quantity of fluid of an orange-green color, and called bile,

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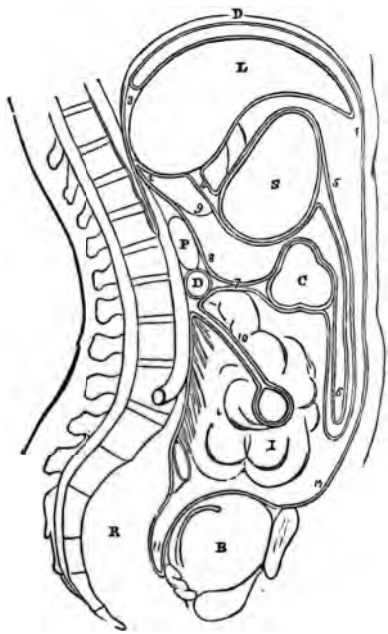
the liver? Do you suppose other animals have livers? Why? ¶ 134. What does

is constantly passing from the blood-vessels, and of course from the blood. From the cells tubes commence, which gradually uniting, at last form one which leads from the liver down into the second stomach, through which bile can of course pass from the system—therefore,

Fig. 44.



134. *The liver answers* the requirements of an organ adapted to fulfil the duties of excretion.

135. *The liver may be considered of use* in separating a certain amount of a certain kind of useless substance from the blood.

[The blood which remains ofter the separation of the bile, passes into veins and returns to the right heart. The reason why the liver should be placed where it is, is, that other duties may be fulfilled by its means, as hereafter shown.]

CHAPTER VII.

Second Stomach.

If we go back to the main artery we shall, by following another branch, soon arrive at the sides of the second stomach. This is a long narrow tube, 7 7 7, fig. 1, Pl 2, terminating in a shorter but larger one, called the colon, 6 6, fig. 1, Pl. 2. In the sides of these the branches of the arteries terminate in a very extensive net-work. From this in health a greater or less amount of substance is constantly passing into the second stomach, and thus from the system.

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the liver answer? How? ¶ 135. Use of the liver? The blood which is not formed into bile passes to where? Does it now contain any useless substance? (Yes.) What two kinds have been now removed? Describe the second stomach? ¶ 136.

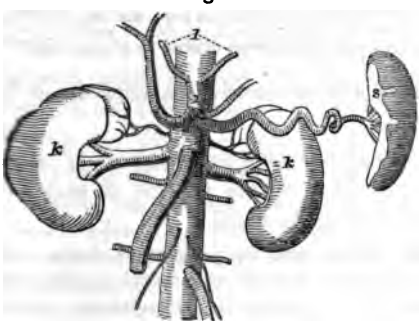
136. *The second stomach and colon answer* the requirements of an organ, adapted to fulfil the duties of excretion.

137. *The second stomach may be considered* of use in separating a certain amount of a certain kind of useless substance from the blood.

CHAPTER VIII.

The Kidneys.

Fig. 45.



If again we return to the main artery we shall soon find one large branch leaving each side of it, and in a short distance terminating in the kidney *k k*, fig. 45. This compares sufficiently well with the same organ in almost any animal. It is situated in the loins, on the side of the body of the back-bone, and a little distance from it. The outer part of the kidney, called the cortical (bark) part, is mostly composed of millions of tubes, converging to the centre of the kidney, fig. 46, and opening into a cavity, called its pelvis or basin; from this a tube called ureter leads down and opens into the vesicle. In the sides of the tubes are found the capillary blood-vessels, which receive the blood from the arteries, and from which certain parts of the blood are removed into the tubes, from which they pass into the pelvis, thence into the ureter, etc.

Fig. 46.

138. *The kidneys answer* the conditions required of an excreting organ.

139. *The kidneys may be considered of use*, by removing from the blood a certain amount of certain kinds of useless substance from the blood.

[*If we examine what is removed by the kidneys, we find sometimes that a large, at others a very small quantity of water*, in which is dissolved or suspended a large or

smaller quantity of solid substance. *The varying quantity of water worthy of especial notice.*]

CHAPTER IX.

The Perspiratory Glands.

If we return to the main artery we shall find a great multitude of its branches, lead ing us to certain parts of the skin, called the perspiratory glands. These are scarcel as large as mustard seeds. They are chiefly composed of a coiled tube of exceedin delicateness in every respect. It also leads to the surface of the skin, where it termi nates. Its opening being what is called a pore of the skin. See fig. 1, 6 & 7. Ther are millions upon millions of these glands and their opening pores, and thus there an almost incalculable extent of surface in the tubes, in the sides of which are th capillary blood-vessels, in which the cutaneous (skin) arteries to a great degre terminate.

140. *The perspiratory glands answer* the requirement of an excreting organ.

141. *The perspiratory glands may be considered of use,* by removing from the blood a certain amount of certain kinds of useless substance from the blood.

[If we examine what is removed from the perspiratory glands, we shall find that very various quantities of water are removed at different times, containing a greater or less quantity of solid substance. We must distinguish between this and the oily substance generally found in greater or less quantity upon the skin. This is formed in glands called sebaceous (oil producing), the tubes of which sometimes open directly on the surface, but more usually in the hair tubes, fig. 1.]

142. *The use of the oil* is to keep the skin in good condition, prevent cracking, etc., and to ward off the effects of external objects, etc.

Inf.—It is very important that a good supply of oil be caused to flow out upon the skin.

143. *The action of the skin* is especially worthy of our notice. 1st. Because the duty it ought to fulfil is of great

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What do the second stomach and colon answer? ¶ 137. Use of the second stomach? Describe the kidneys? ¶ 138. What do the kidneys answer? ¶ 139. Use of the kidneys? Describe the perspiratory glands? What do the perspiratory glands answer? How? Use of them? What shall we find removed by them? Where is the oil of the skin formed? Use of it? *Inf.*? ¶ 143. Why action of skin worthy of

importance. 2d. Because being so exposed as it is, it is especially liable to derangement.

144. *That the duty* of the perspiratory glands may be fulfilled, it is necessary—1st. That they should receive blood. 2d. That they operate upon it. 3d. That there be a free exit from the gland to the surface.

145. *That a proper quantity of blood be received by the glands*—1st. Exercise of the muscles must be taken; for this, as every one knows, causes the blood to flow more freely through all parts of the body. 2d. The skin must be rubbed, for this circulates the blood. 3d. The general health must be good; for every one knows that in good health the skin is more full of blood than when a person is feeble, for then the skin is usually bloodless. 4th. The skin must be protected from too long exposure to the cold.

[How long a person may be exposed to the cold, whether air or water, depends upon many circumstances. It should never be until a sensation of chilliness is produced, for this rarely occurs when there is a good supply of blood in the skin, as hereafter shown; this will depend upon the natural constitution, upon the health, and the weariness or exhaustion of a person.]

146. *That the glands may operate on the blood*, it is necessary—1st. That they should be in good health. 2d. That the general health of a person be good, and his system unexhausted.

147. *That the excretion may be poured out upon the skin*, its surface must be kept clean, by rubbing, washing, friction of the clothing, etc.

[There is great likelihood that the excretion, the oily substance, and the dust of the atmosphere will form a glazing or gum upon the skin unless it is frequently attended to and cleansed. How frequently this must

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notice? ¶ 145. What is necessary that a proper quantity of blood may be received? How long may a person without injury be exposed to the cold? 146. That the glands may operate on the blood, what is necessary? ¶ 147. That the excretion may be poured out what is necessary? What is likely to be the case? How frequently does

be done is not certain. The frequency will differ in different cases. Some think once per week sufficient, and others think every day essential to health. I suppose twice or three times per week absolutely necessary for the most perfect state of the skin.]

148. *The amount which passes out from the body by the action of the skin* is so great—being found by experiment no less than from 1 to 5 pounds every twenty-four hours in health—that great care should be taken to keep the clothing worn, during the day or night, clean.

Inf. a.—The bedding should be aired every morning by being thrown open, and every few days by taking it out doors.

Inf. b.—There should be different clothing worn next the skin at night from that worn during the day, that it may be aired meantime.

[The frequency with which the clothing should be changed will depend upon many different circumstances. Some think that to change the clothing worn next the skin once per week is sufficient But I think that twice or thrice per week is seldom enough.]

Review of Excreting Organs.

149. *The excreting organs agree* in three things. 1st. They receive blood through the arteries. 2d. An extensive net-work of capillary vessels exist in each. 3d. They separate useless substance from the blood. 4th. They communicate with the surface of the body. 5th. The blood flows from them through veins. 6th. Their vigorous action depends upon the reception of blood, and upon their own and the general health.

150. *The excreting organs differ* in their forms, color, positions, structure, and the character of the useless substance they remove from the blood.

151. *Though the immediate effect of want of action* is greater in case of one excreting organ than of another, yet,

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the author think a person should bathe? ¶ 148. How much substance is removed by the skin? *Inf. a.*? *Inf. b.*? How frequently should clothing be changed? What kind of sensations ought to be produced by proper bathing and changing the clothing? What effect ought to be produced upon beauty? ¶ 149. In what do the excreting

in a short time *the inaction of any organ* would produce disease and death, if the substance it ought to throw out were allowed to accumulate.

[Hence, if one organ be deranged, another excreting organ is frequently caused to fulfil its duty more or less thoroughly.]

Illus. a.—When the skin is deranged in the winter time, the lining of the air-passages will be caused to fulfil the duty of the skin to a more or less perfect degree, producing what is called a cold.

Illus. b.—When the skin is deranged in summer, the second stomach will be caused to, in part, remove what the skin cannot.

Inf.—To prevent "a cold," or derangement of the second stomach, we must take especial care of the skin.

Organs agree? In what disagree? ¶ 151. What would be the effect of inaction of any excreting organ? If any organ be deranged, how is its duty fulfilled? *Illus. a.*? *Illus. b.*? *Inf.*?

BOOK II.

NUTRITION.

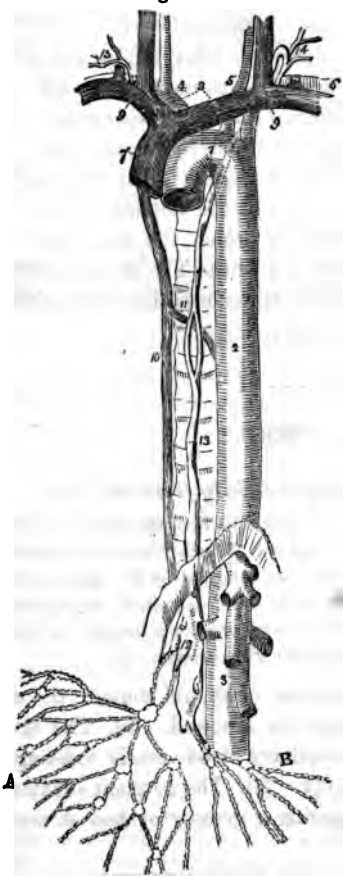
Means by which the System is Renewed.

[When, by the action of the various parts of the body, certain portions of them have become useless and are removed, it is necessary that their place be supplied by new substance adapted to use. Accomplishing this is called the process of nutrition. The substance by which it is accomplished, is called nutriment or nourishment. Now it is evident that as the different parts of the body are composed of such different substances, they could not all be nourished by the same nutriment. This must therefore be of different kinds. Again, as the different parts are sometimes active and sometimes at rest, they will require at different times a greater or less amount of their peculiar kind of nutriment. To supply them with it, what could be more ingenious than to have a set of tubes leading into all parts of the body, if through these tubes there was constantly flowing a current of fluid in which a proper amount of the various kinds of the desirable nutriment was dissolved or suspended? This beautiful arrangement exists. The systemic arteries are such a set of tubes. In addition to those branches which lead to the excreting organs, we have a great number leading into nearly every part of the body, and terminating in a network of capillaries, from which, on the other hand, the veins arise. Thus, by the action of the left heart, &c. a flow of blood is caused throughout the whole body, and the blood is in part composed of nutriment. If we examine, to learn where it enters the blood-vessels, we shall find it is at the corner or angle,

What is nutrition? What is nutriment? Can all parts be nourished by the same kind of substance? Could all parts of a watch be made of the same materials? Could the brass which forms the wheels be made into the crystal? Do the parts of the body in equal times always require equal quantities of substance? What would be an ingenious arrangement to supply the organs with the required substance? What is the name of such tubes? How are they arranged to accomplish such purposes? What effect has the action of the left heart? Where does the nutriment enter the

where the jugular unites with the left arm vein, as seen at 14, fig. 47,

Fig. 47.



Here we find a fluid appearing in color much like milk, of a somewhat reddish cast, to be poured into the blood-vessels. If we then trace the tube through which it flows, and called thoracic duct (chest tube) we shall find it extending down in front of the back-bone and slightly across it, 13, fig. 47, as far as to 12. Below this point we shall find many branches like the roots of a tree, which we could trace to the sides of the second stomach. The fluid which they contain is usually quite white or milk-colored, and called chyle. This same kind of fluid we shall, in the next place, find in the canal of the second stomach; where at times we find it to be formed from a part of a gray paste, called chyme. This, we soon ascertain, comes from the stomach, sometimes called the first stomach. Upon examination we find it to be formed there from the food. This we find to be chewed and mingled with saliva in the mouth. Previous to this we observe, as a general thing, it is cooked; and lastly, we know, as we

blood-vessels? From whence does the nutriment come into the arteries? What color has chyle? In what respect does it appear to differ, where it enters the veins, from what is found in the branches? Where does it come from into the lacteals? From

have seen, that certain kinds of substance must be taken as nutriment, viz., such kinds as can be formed into the various parts of the body—— therefore,]

152. *In the process of* nutrition nine things are to be noticed. 1st. The *character* of food as nutriment. 2d. The *cooking* of food. 3d. The *buccal* (mouth) preparation. 4th. The *chymification* (making into chyme) process. 5th. The *chylification* (making into chyle) process. 6th. The lacteal process, (the process taking place in the lacteals.) 7th. The sanguinification, (the process by which the fluid from the lacteals is changed into blood.) 8th. The distribution of the nutrient blood. 9th. The transformation of the blood into the constituents of the body.

CHAPTER I.

Formation of the parts of the Body from the Blood.

[How this and that part of the body take from the blood the particular parts they require, is not known. Whether, also, the substance exists in the blood precisely of the same nature as the parts it is to nourish, and is therefore merely, as it were, deposited; or whether it undergoes a certain change as it is leaving or after it has left the blood-vessels, is not known. What is known with certainty, is,]

153. 1st. The blood contains, or should contain, the material by which the part can be renewed. 2d. The blood passes into a net-work of capillary blood-vessels existing in or near every part of the body. 3d. The nutrient substance leaves the net-work, and passing a greater or less distance, becomes a part of the body.

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what is the chyle formed? Whence comes the chyme? From what is it formed? Whence comes the food? What process does food undergo before it is taken into the mouth? ¶ 152. How many things to be noticed in the process of nutrition? 1st? 2d? 3d? 4th? 5th? 6th? 7th? 8th? 9th? Does the substance which is to form any part exist in the blood? Does it exist in the same form as in the part? ¶ 153.

Illus.—In the muscles the net-work exists in the substance of the muscle, and the meshes are very small, and of course the nutrient substances have but a trifling distance to pass. In case of the cartilages, for instance the cartilages of the back, the net-work would be found on the sides of them, and the nutrient substances have quite a distance to travel to the inside of the cartilage.

Inf.—Some parts will be nourished much more speedily than others.

[Hence, we find many times, that the cartilages of the spine do not become firm and resisting when a person is growing rapidly, and thus allow a person to lean forward, from which condition they will in due time recover, if proper care be taken.]

CHAPTER II.

Distribution of Nutrient Blood.

[It is evident that as the different parts are differently active at different times, so different amounts of nutriment will be required by them, and the action of the part itself ought to cause it to receive an increase of blood. It is so.]

154. *The causes of distribution of the blood are*—1st. The action of the part receiving it. 2d. The contraction of the muscles. 3d. Rubbing the system. 4th. Contraction of the capillaries. 5th. Contraction of the arteries. 6th. Contraction of the heart.

[1st. By the action of the part receiving the blood, is meant that change which is going on in it, and which causes the blood in its immediate vicinity to be strongly attracted toward it.*]

[2d. The contraction of the muscles will necessarily press out the blood which they contain, and for the time of their contraction will pre-

* The suggestion of this valuable and curious idea is wholly due, I believe, to that accomplished scholar, Professor Draper, of New-York, whose school-books on chemistry and philosophy, if not the best, are among the best, and exhibit in a peculiar degree the clearness of his mind, and a mode of thinking most practical, philosophical, and admirable.

What is known with certainty? *Illus.*? *Inf.*? Are the cartilages of the back always firm? Why will different quantities of nutriment be required at different times? ¶ 154. Causes of distribution of blood? What is meant by action of part receiving

vent the influx of more. But the instant the muscles relax, the nutrient blood pours into them, and if sufficient time elapse before they are again contracted, all parts will experience a benefit. If not, the change continues to take place in the muscle faster than it is renewed.]

Inf.—The more speedily the muscles are contracted the sooner do they become unfit for use, and cause fatigue.

Illus. a.—A horse quickly driven, as on fine roads in good weather, soon shows the effect, while driven slowly in bad going, though with heavy loads, he improves.

Illus. b.—A lady sewing upon the lightest work will feel fatigued from the quickness of her motion, though at first it would not seem as if her work were hard.

[But the action of the muscles will not only quicken the flow through themselves, but through all the other organs.]

Inf.—When from thinking the brain requires renewal, and is causing heavy sensations, we should exercise the muscles.

[3d. From the structure of the arteries and veins, rubbing the system must quicken the flow, not only through the part rubbed, but through every part.]

[4th. How much the action of the capillaries will increase the flow of blood through them, is uncertain. My belief is, that it is considerable, and that the power with which it is exerted depends, as hereafter shown, upon the constitution, the health, and the exhaustion or freshness of a person's general strength.]

[5th. Some suppose that the arteries have an active and very important effect in driving the blood through them; others do not.]

[6th. The action of the heart is very great, as is almost self-evident, its power depending as in case of the capillaries.]

CHAPTER III.

Sanguinification of Chyle.

[Upon the topic of this chapter, little which is definite, can be said. We find the chyle of a reddish-white color coming into the veins ming-

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blood? How will contraction of the muscles increase the circulation of blood? *Inf.*? *Illus. a*? *Illus. b*? Will the action quicken the action through any other organ than themselves? How? *Inf.*? How can rubbing the system quicken the flow of blood? What is the action of the capillaries? If the capillaries should contract what would be the effect on their contents? Which way

ling with the blood. Its particles can easily be traced down into the right heart, and thence to the lungs, where, with the returned blood, it is subject to the action of the air if any such action takes place. Of this we are not certain. When it returns from the lungs it cannot be distinguished from the rest of the blood of which it composes a part.]

CHAPTER IV.

The Lacteal Process.

[In what the lacteal process consists is not now known. It is not yet determined by what means or cause the chyle is made to pass from the second stomach into the lacteal roots—nor is it known by what cause it passes through them up into the blood-vessels. In the course of the lacteals are small knotted appearing parts, A.B. fig. 47, called glands. The use of them is not known. The lacteal fluid seems somewhat altered after it has passed through these.

CHAPTER V.

Chylification.

155. *Chylification is* a process which takes place in the second stomach, and consists in a change of a certain part of the substance received from the stomach in the form of a gray paste, into a white fluid.

[Why the nutrient portion of the food should be formed into a fluid in the second stomach, is evident enough, viz., that it may pass into and through the lacteals and blood-vessels.]

156. *Chylification takes place by the admixture of four substances*, viz., gall, bile, pancreatic juice, and mucus, with the chyme; and by the slow passage of the mixture through the warm tube in which the process takes place.

would they be forced? Do the arteries propel the blood? What effect has the action of the heart? What is meant by sanguinification of chyle? What is said upon that process? ¶ 155. What is chylification? Why should the chyle be fluid? To form

Fig. 48.

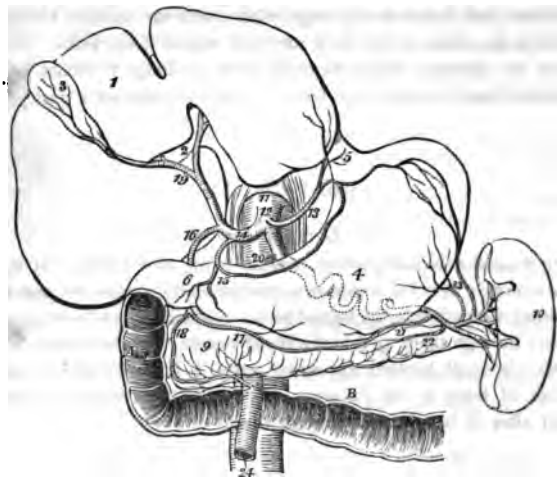

Fig. 48.—1, Liver turned up and laid back. 2, Fissures in the under surface of the liver. 3, Gall-bladder. 4, Stomach. 5, Lower portion of œsophagus. 6, Pylorus 9, Head of pancreas. 22, Small extremity of pancreas. 10, Spleen. 13 to 24, Blood-vessels. A, Opening of the ducts from the pancreas, liver, and gall-bladder. B, Duodenum open, the folds of its internal surface may be seen.

[Why these substances are necessary, we cannot now say: as we do not know precisely what the intimate process is which takes place here, we can only give certain facts; therefore,]

The second stomach is a tube, consisting of its lining, its muscular and its peritoneal coats. Its lining is very delicate and beautiful, arranged, as the expression is, in folds, fig. 48, (see the corresponding part of an animal.) Its muscular coat is composed mostly of rings, with some fibres extending lengthwise. Its peritoneum is its outer and pearl-colored shining coat. About three inches from its upper extremity, viz., from where it commences at the stomach, an opening of two tubes exists. If we follow one of these it leads us into a part of the body called the pancreas, fig. 48, (or sweet-bread in case of animals.) It is not very large, lies across the body from right toward the left, just back of and below the stomach, being about midway between the front and back part of the system. It is of a cream-color and uneven surface, about eight inches long, two wide at the right and one at the left extremity, and from one inch to one-half thick. The tube leading to it divides and subdivides in all its parts, terminating in clusters of cells, in the sides of which a net-work of capillary vessels would be found. Usually at the same point, where the pancreatic duct leaves the second stomach, another tube commences which leads up toward the liver. At the distance of about two inches a branch from it leads off, and turning over opens into a

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chyle what four substances seem necessary? Describe the second stomach? Describe the pancreas? Describe the liver? Describe the gall bladder? How many kinds of

conical sac or bag, holding from one to three ounces, called the gall-bladder. The main tube continues on into the liver, where it divides and subdivides, and is supposed to terminate in cells, in the sides of which would be found a net-work of vessels. At this place it may be mentioned, that the *liver receives two kinds of blood*—one, as before said, through a branch of the main artery; another is received through a vein called vena porta. It is formed by the uniting of the veins leading from or draining the stomach, second stomach, pancreas, and spleen. This large vein divides and subdivides in the liver, and is supposed to terminate only in the net-work situated in or upon the cells of the liver.

157. *The mucus is a slimy substance, much like white of egg;* is formed in the lining of the second stomach—hence called the mucous membrane.

[Its use is thought by some to be merely to lubricate this canal; by others it is thought to be excreted substance; by others it is thought to assist in forming the chyle.]

158. *The pancreatic juice* is a fluid appearing much like saliva; is formed in the pancreas, and is slowly poured into the second stomach. Its use is to assist in forming the chyle.

[Some think that it is an excretion.]

159. *The bile is* an orange-green, limpid, rather sweetish fluid, formed in the liver, and of great use in two respects. By it the chyle is formed, and the blood also freed from an impurity.

[Some think that the bile should not be called an excretion. Its precise use in the digestion process, we do not know, but it seems undoubtedly necessary.]

Inf. a.—More of it would seem necessary when the food passes into the second stomach, at some times than at others.

Inf. b.—It might be very possible that some kinds of food would require more than others.

Inf. c.—More of it would be required when much chyle is to be formed.

Inf. d.—There ought to be such an arrangement, that an increased quantity of bile would be formed when the chyme requiring it is about to enter the second stomach.

[There is. This is one reason why the veins from the stomach lead to the liver—without doubt.]

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blood does the liver receive? From whence? ¶ 157. What is the mucus? What its use? ¶ 158. Describe the pancreatic juice? ¶ 159. What is the bile? What do some think of the bile? *Inf. a.*? *Inf. b.*? *Inf. c.*? *Inf. d.*? ¶ 160. What is the

160. *The gall is* a very dark green, ropy, and very bitter fluid found in the gall-bladder.

[Its specific use in distinction from bile, is not known; some believe that gall is merely altered bile which has passed from the liver into the gall-bladder as a reservoir.]

[Little by little the chyme passes into the second stomach, becomes saturated by the substances it soon meets; and soon, by some process, the intricate nature of which we do not yet understand, a few particles of chyle are formed, and gradually more and more, which rapidly pass out of the second stomach into the lacteals which commence in its sides.]

161. *The quantity of chyle which will be formed in the second stomach* will depend—1st. Upon the quantity of chyme received. 2d. Upon the quality of it, (which depends, of course, upon its nature, and the manner in which it has been prepared.) 3d. Upon the quality and quantity of the bile, gall, pancreatic juice, and mucus. 4th. Upon the requirements of the body. 5th. Upon the health of the system generally, and upon the health of this part in particular.

[It may happen, therefore, as it often does, that all the really nutritious part of the chyme is not changed into chyle, *and is of course lost or wasted.*]

Inf.—It is very important, in feeding man or animals, that such kind of food be used, and that it be so prepared, that all that can be formed into chyle shall be.

462. All the chyme which is not formed into chyle, together with any bile, gall, pancreatic juice, mucus, or other excretion, that is not required in the second stomach, passes into the colon.

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gall? How does the chyme make its appearance in the second stomach? What then and there takes place? Upon what does the quantity of chyle depend? Is all the nutriment of the chyme necessarily changed into chyle? *Inf.?* What passes into the

CHAPTER VI.

Chymification.

163. *Chymification consists* in the change of the food, swallowed from the mouth, into a gray paste, called chyme.

164. *Chymification takes place* by the mixture of the food with a fluid called gastric or stomach juice and mucus, accomplished by the contractions of the stomach, the warmth of which also preserves the necessary elevated temperature in the food.

[What intimate process takes place in the food, we do not know, and therefore cannot say what character the fluids of the stomach ought to have. Indeed, we can only state certain facts with which we are perfectly acquainted.*

* As the stomach is hidden from our view under ordinary circumstances, it might be thought by some, that statements in respect to the operations of this organ must be entirely conjectural; and so they were until within a few years. In the year 1822, however, a young man, Alexis St. Martin by name, a Canadian by birth, but at the time in Michigan in the United States service, was accidentally wounded by the discharge of a gun, the muzzle of which was about a yard behind and a little to the left of him, and pointed across his side, which was torn open by the buckshot, and somewhat burnt by the powder with which the gun was loaded. Dr. Beaumont, U. S. surgeon, was immediately called. He found, as he says, a portion as large as a turkey's egg, of the left lung, pushed out through the opening made; and noticed, also, that the food eaten for breakfast by St. Martin about an hour before, was passing out in a half-digested state. Of course, the stomach was injured. Strange to say, in about ten months after this, St. Martin was well, to the great credit of Dr. B. Still more strange, and fortunate for the world, and apparently without injury to St. Martin, though the opening in the side closed up so as to cover in the lung, the edges of the wound in the stomach refused to "grow together," but grew to the edges of the external wound in the side—thus leaving an opening, about two and a half inches in circumference, through the side into the stomach. Through this opening any thing could be passed into, or taken from the stomach, or the stomach could be examined under any different circumstances. In about ten months from the recovery of St. Martin, a kind of valve or apron began to grow down from the upper edge of the opening of the stomach. It hung, so to speak, within the opening like a curtain, retaining the food; but it could

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colon? ¶ 163. What is chymification? ¶ 164. How does it take place? Describe the stomach? In what figures in the book is the stomach shown? Where is the stomach

The stomach is a pouch or sac of larger or smaller size, according as it is filled or empty. The sides are composed of three conspicuous layers. The inner is called the lining or mucous coat. Its surface has a very beautiful velvety appearance. The muscular coat is composed of fibres passing in several different directions, so as to completely surround the lining. The external is called the peritoneal. Its situation and appearance, when distended, has already been shown. Its position varies of course with every breath, being pressed down at every inspiration, and moved upward at every expiration. The stomach has two openings, both of which are upward. One is a little to the left of the centre of the body, and about one-third the length of the stomach from its larger or left extremity. It is called the cardiac (heart) or œsophageal orifice. It is closed, except when the food is passing, by the contraction of some circular muscular fibres which exist about it. The other opening is at the small extremity, under and quite near to the liver. It is called the pyloric orifice. It is closed, except during the exit of the chyme, by a strong band of muscular fibres.

[We will now suppose ourselves looking into the stomach about to receive food. It is contracted, of course, and occupies a small space very nearly in the centre of the body, just below the level of the pit of the stomach.]

165. *The first thing to be noticed on the reception of food by the stomach is*, that it is gradually distended as mouthful after mouthful of the food is swallowed.

166. *The second thing is*, that the inner surface of the stomach becomes somewhat flushed with red.

[This is produced by the increased flow of blood, it being necessary, in order that the gastric juice may be formed. Dr. Beaumont also tells us, that this appearance could be sometimes observed before the reception of the food, viz., when food which was very highly relished was yet in the mouth, or even upon the plate.]

Inf. a.—As the blood is required by the stomach in large quantity in the process that goes on there, we ought not to labor mentally or physically just before, during, or for a short time after eating.

Inf. b.—It is important that we relish the food we eat.

167. *The third noticeable thing is*, that drops of fluid like perspiration start out upon the entire inner surface.

be pressed in, and the stomach examined as before. Dr. B. hastened to improve the opportunity; and with much apparent accuracy and particularity, made notes of his observations and experiments. With *his* notes in hand, and the results of so many experiments as have been tried on man and animals, we may advance to the subjects under consideration with considerable assurance of being compensated with positive knowledge.

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when contracted and empty? ¶ 165. What is the first thing to be noticed in the process of chymification? ¶ 166. The second? How is this produced? What does Dr. Beaumont tell us? *Inf. a.*? *Inf. b.*? Ought animals also to relish their food? How can a person produce a good appetite? ¶ 167. The third thing? How long does the

[This is gastric or stomach juice. It continues to come into the stomach during from five minutes to half an hour, according to the health of the system, the kind and quality of food eaten, and the requirements.]

Inf. a.—As when the system is unwell, the juice does not come freely into the stomach; it will not only be useless, but injurious, to eat.

Inf. b.—As the quantity of gastric fluid which appears, is only adapted to digest what food the system requires, if we eat more than that we shall be injured—such overplus not only being wasted, but injuring the stomach.

Inf. c.—As about half an hour is usually required for the needed gastric juice to be formed from the blood, we ought to allow, at least, this space of time after eating, before we indulge in mental or physical labor.

168. *The fourth thing to be observed is*, that the stomach begins to contract in such a way as to move the food about in it, and mix it well with the gastric juice, etc.

[This takes place by the alternate contraction of the muscular fibres of different parts of the stomach.

169. *The fifth observation to take is*, that the temperature of the stomach, and of course of the food, is somewhat elevated during the process.

Inf.—Taking a large quantity of any cold beverage, ice-cream, or aught which for any length of time lowers the temperature, must be injurious.

170. *The last thing to be noticed is*, that gradually the food begins to digest, and little by little to be formed into chyme, which, as soon as it is formed, passes into the second stomach.

171. *The rapidity with which this is done* depends upon the nature of the food, how it has been cooked and seasoned, chewed and mingled with the saliva, its quantity, the rapidity with which it has been swallowed, the consistence of the

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gastric juice continue to come into the stomach? *Inf. a?* *Inf. b?* *Inf. c.?* Ought we to feed an animal quickly after a drive or other labor? Ought we to drive or cause an animal to labor during or immediately after eating? ¶ 168. The fourth thing? ¶ 169. The fifth? *Inf.?* ¶ 170. The last thing? ¶ 171. On what does the

food, the wants of the system, the general health, the especial health of the stomach, the mental or physical exercise taken.

[1st. The gastric juice can, of course, saturate some kinds of food more easily than others. This might perhaps account for the raw cabbage digesting in two hours, while the same food boiled would require four and a half. So also, heavy food would not be expected to receive the juice as readily as light food. But why venison should digest in an hour, while beefsteak should not in less than three, cannot well be accounted for. In the case of St. Martin, it was found there was great difference in case of apparently similar kinds of food. 2d. In the next place, the mode of cooking was found to make great difference, something of which we might presuppose, but not all. It is not to be supposed that the case of St. Martin is to be taken as a rule for all persons, for doubtless there would be a vast difference in case of different persons. 3d. It is found that the action of what is called spices, and some other things, have the effect to increase the flow of blood, for the time being, in many cases. But it does not follow, that this will be advantageous; on the other hand, it is very injurious. It tends not only, but decidedly does produce disease in the stomach. It is quite evident, that if it should cause more food to be digested in the stomach than the system requires, it will not be formed into chyle in the second stomach, or if it should, it will only produce still farther harm if it pass into the blood-vessels. 4th. Chewing or masticating the food thoroughly, would, of course, facilitate very much the action of the gastric juice; and Dr. Beaumont testifies, that the admixture of a proper quantity of saliva is of no small importance. 5th. If too large a quantity of nutriment be taken, the gastric juice being mingled with the whole of it, cannot digest that portion which it is capable of doing with ease. On the other hand, it is very important that a sufficient quantity of food be taken to reasonably distend the stomach, for not only will more gastric fluid be formed, but it will be more easily managed by the contracting stomach. The same is also true of the second stomach. 6th. When the food is rapidly swallowed, it cannot be so perfectly and speedily exposed to the action of the gastric juice and mingled with it. 7th. The consistence of the food must be about that of paste, ere the gastric juice makes its appearance. If well mingled with saliva, almost any food will in con-

rapidity with which chyme is formed depend? How can the gastric juice act most favorably? How much food should be taken? What should be the consistence?

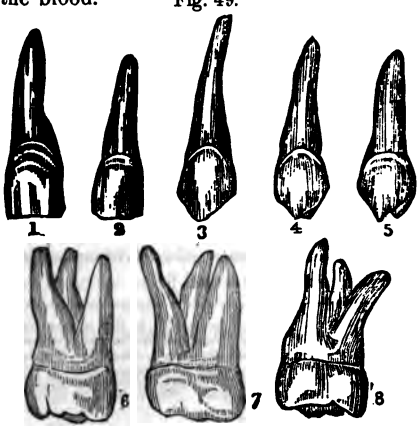
sistence be quite right. If too much drink be taken, there is danger it will not be removed from the stomach rapidly enough. The first process, when milk is swallowed, is curdling it; next, the fluid portion is at once removed into the veins of the stomach, and the remainder is digested. If a person be thirsty, and drink in proper quantity, it passes from the stomach at once into the blood-vessels. Sometimes, also, a little fluid in addition to the saliva will be of advantage, by producing a proper consistence in the food. 8th. The wants of the system, in respect to food, are signified by the sensation of hunger. This is always to be satisfied when health prevails, by taking food well prepared, and chewed slowly, into the stomach. In ill health, it must not be gratified without the greatest care. 9th. If the general health be bad, or if the stomach be diseased, it is evident that much food cannot be digested.]

CHAPTER VII.

The Buccal Process.

172. *The processes taking place in the mouth are*—1st. Mastication, performed by the action of the jaws and the teeth, and of muscles which subject the food to their action. 2d. Salivation, which consists in the formation of saliva from the blood.

Fig. 49.



The teeth are twenty in the first set; thirty-two in the second, eight of which are seen in fig. 49. They are composed of the fang or root by which they are fastened in the jaw, and of the crown. They are also formed of an outside and inside part. That which is at the outside of the crown is called the enamel. It is a thin shell, and may be compared to the glazing of a plate. The muscles engaged in mastication are those of the jaws to move them, and those of the cheeks and tongue to bring the food under the teeth. The parts in which the saliva is formed are six in number, three upon each side. At the centre of the cheek is the opening of a tube which leads back just underneath the outer skin and can be

Fig. 50.

felt like a cord, to an organ, called the parotid gland. This can be felt just in front of the lower part of the ear, being the part most usually affected in case of the "mumps." In this the tube, called Steno's duct, divides and subdivides, the small twigs opening into clusters of cells, on the sides of which are formed a net-work of vessels. The saliva is here formed, and hence finds its way into the mouth. Another gland is found upon either side, between the centre of the lower jaw and the tongue—it is called submaxillary. Another gland still smaller is found further forward—it is called sublingual.

173. *That the teeth may serve their purpose for the longest time, they must*—1st. Be well formed. 2d. They must not be used upon hard substances. 3d. Quite hot or cold substances must not come in contact with them. 4th. They must be kept clean. 5th. Whenever any decay occurs, the part must be carefully removed, and the tooth filled with proper material. 6th. They must not be allowed to crowd upon each other.

[1st. They cannot be well formed without a child be fed at the time when they are growing, upon the right kind of food, and without, also, it have good health to prepare the food for the use of the teeth.]

[2d. Nuts, pins, hooks and eyes, knots, thread, etc., bitten upon, bent, cut off, etc. by the teeth, often cause small bits of the enamel to be broken off, when, the inside being exposed to the air, decay commences.]

[3d. Hot or cold substances, by contracting or swelling the outside of the tooth before the inside can be acted on, would tend to cause it to "glaze-crack" as a plate, pitcher, or tumbler would.]

What if too much drink be taken? What is the use of hunger? Is this always to be satisfied? Can food be digested in ill health? ¶ 172. What are the buccal processes? Describe the teeth? What muscles are engaged in mastication? Describe the parts in which the saliva is formed? ¶ 173. To preserve the teeth what is necessary? What is necessary to their perfect formation? Effect of hard substances? How have you

[4th. Substances collecting about the roots of the teeth cause them to loosen in their sockets, the gums to become spongy, etc.]

[5th. When the teeth crowd upon each other, after a person has arrived at mature years, one had better be extracted. When a person is young they frequently will, or will be irregularly placed, because the jaw is not yet large enough. These things either become right themselves or are easily righted as a person grows older.]

174. *When the food has been masticated* it is gathered into a ball, rolled over the tongue into the throat, from whence it passes into the stomach through a tube called the œsophagus or meat-pipe.

The œsophagus or meat-pipe is composed of a lining similar to that of the mouth, surrounded by a muscular tube composed mostly of rings. By successive contraction in one direction they cause the food to move down into the stomach; by contracting in the opposite direction they convey it up into the mouth.

[As the opening into the windpipe is just beneath the back part of the tongue, whatever is swallowed must pass over it. At such times, therefore, it should be closed, as it ordinarily is.]

CHAPTER VIII.

Cooking.

175. *It has been already seen that the object of cooking should be*—1st. To cause the nutriment of the food to be most easily digested. 2d. To cause the food to better relish.

[There can be no one rule laid down by which all persons could be governed, there is such a difference in the constitutions, habits, etc. of persons. It may be generally said, that food heated to the boiling point is best, though there are many exceptions. Food that is light is better than heavy or solid. So also is that which is well done, neither too much or too little. We are also so constituted, that the mingling of certain articles of food facilitates their digestion as well as improves

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ever seen the teeth wrongly used? What should be the temperature of things brought in contact with the teeth? How can the teeth be kept clean? ¶ 174. What becomes

their relish. Also, if food be used in certain order, each article causes its successor to relish better.]

CHAPTER IX.

Nourishment.

176. *Food, it is evident, should consist of* that kind and quantity of nutriment which the system requires under the circumstances, and of such a quantity of other substance as shall assist in reasonably distending the stomach.

Inf.—The quantity of the useless substance which should be used will depend on the amount of nutriment the system requires, and the size of the stomach.

[The question now is—how should we be able to distinguish the different kinds of nutriment? How shall we be able to know precisely how much of each we need, etc.? In the present state of knowledge this cannot be precisely answered. Almost every article we use in food contains more or less of some kind of nutriment. This question will, however, be again noticed at the close of the next book.]

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of masticated food? Describe the œsophagus? ¶ 175. What should be the objects of cooking? ¶ 176. Of what should food consist?

DIVISION II.

MEANS BY WHICH THE BODY IS PRESERVED OF A PROPER TEMPERATURE.

[In order that the various parts of the body may fulfil their duties, they must be preserved of a proper temperature; for we find, that, when they become either too warm or too cold, their duties are irregularly performed or cease altogether. That they may be preserved of a proper temperature there must be both a warming and cooling process going on all the while more or less actively. Hence this division will be subdivided into two books.]

BOOK I.

177. That the body may be kept properly warm, three things are necessary. 1st. Heat must be produced. 2d. It must be distributed. 3d. It must be preserved.

CHAPTER I.

The Heating Process.

178. In the production of heat, three things are to be noticed as efficient. 1st. Exercise. 2d. Food. 3d. Air.

That the various parts of the body may fulfil their duties what is necessary? To preserve them of a proper temperature what is necessary? ¶ 177. That the body

SEC. 1.—*Exercise.*

[That the production of heat is in some way connected with exercise every one is aware from what he must have observed, that the more he exercises the warmer does he grow. This is explained in different ways by different persons. Some think it is because more air is breathed when we exercise. Some think, that the heat is caused by the acceleration of the motions of the blood. Some think that the heat is greatest in the exercised parts, because more blood circulates there at the time. But from all the arguments examined, I am inclined to think that:]

179. *Exercise produces heat* because the changes which take place in the exercised part are such that they immediately result in the production or exhibition of heat.

Inf. a.—The more changes there are taking place in the system the more heat there is produced.

Inf. b.—When the body is not warm enough, we should, if the health will allow, take more exercise.

SEC. 2.—*Food in the production of heat.*

180. *That food is concerned in producing heat is judged* from the facts that the colder the weather the keener is our appetite, the more are we fond of certain kinds of food; and the more do we suffer from the cold the longer we have been without food, and that the food we eat most of in winter will burn.

[1st. Every one observes that his appetite increases in fall, and continues more craving through winter, when it begins to diminish. It is so also with all animals. There must, therefore, be a connection between the food we use and cold weather, and what can extra food be needed for, except to produce heat?]

[2d. Man and all animals are inclined to eat certain kinds of food, viz: those containing fat, sugar, starch, gum, in winter. Sometimes a

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may be kept warm what is necessary? ¶ 178. In the productive of heat what are to be noticed? Did you ever notice any effect of exercise? ¶ 179. How does exercise produce heat? *Inf. a.*? *Inf. b.*? ¶ 180. How is it judged that food is concerned in the production of heat? When does appetite of man and animals increase? When does it diminish? What then must be the case? What kind of food are man and animals

person says, he does not observe but he eats as much bulk in summer as in winter, but, if he do, it ought to be mostly useless food.]

Illus. a.—The squirrels eat the oily (fat) nuts in fall and winter. In spring and summer they eat fern-buds, berries, etc.

Illus. b.—The bees lay up their honey (sugar) in the summer but eat it in winter.

Illus. c.—The swine greedily devour corn and other grain (containing much starch), but in summer prefer green vegetables.

Illus. d.—The cow "browses" the buds, etc. (gum) of trees in winter, but prefers the grass in summer.

Illus. e.—Almost every person loves buckwheat cakes (starch and sugar) with butter (fat), molasses (sugar), in winter, but who would think of eating them in summer?

[3d. A person cannot endure shipwreck or other exposure as long without food, if the weather be cold as if it be milder.]

[4th. If sugar, gum, starch, or fat, be thrown into the fire it will burn.]

[It will be a little difficult for a person not acquainted with chemistry to understand how any thing could burn in the body without injuring it, we are so accustomed to associate with the word burn, the idea of an intense degree of heat. We say, also, that heat burns the wood, etc., by means of which we lose the distinct idea we ought to have. The truth is, it is the change that the wood undergoes in which consists its burning; at the same time heat also is produced, which is the cause of farther change taking place. We are in the habit, also, of applying heat to produce the first burning or change of a bit of wood, but if the change could be produced by some other cause and slowly, heat would be produced all the same but not so rapidly as to injure the body.]

181. *Food used to produce heat* passes through the same process in the mouth, stomach, second stomach, lacteals, and in the blood-vessels finds its way into the lungs, as the food used as nutriment does.

[It is altogether probable that the food adapted to produce heat, is operated on by the juices of the stomach in a different manner from the nutrient food, but the general action is the same in each case. It is usually supposed that the sugar, starch, and gum, of the food becomes

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inclined to eat in winter? *Illus. a.*? *Illus. b.*? *Illus. c.*? *Illus. d.*? *Illus. e.*? Ought we to feed animals on the same kind of food summer and winter? When can a person longer endure exposure to cold, with or without food? Will sugar burn? Have you tried? ¶ 181. Through what processes does the fuel like food pass? What

changed into fat which passes into the blood-vessels. This is not, however, certain. Those substances are very similar to fat, though they appear so different. We know also, that by feeding almost any animal bountifully on either it will become fat, showing that fat can be formed from them.]

182. *Where in the system the changes productive of heat* take place in the food, we cannot say.

[Some think in the lungs. Some think in all parts, as the case may be. Some think, it is first laid down in the form of fat and then taken up again into the blood-vessels. Some think either idea may be at different times correct.]

[We may now with propriety introduce, to close this section, an extract on the general character of food taken from the Second Book on Physiology by the Author of this. In it much more very valuable matter will also be found which the scholar will do well to read.]

183. Food may first be considered as composed of three classes of substances. 1st. Nourishment. 2d. Fuel. 3d. Useless substance.

[Either of the first two become useless if eaten in larger quantities than the needs of the system, in respect to nourishment or fuel.]

Inf.—A person may, therefore, eat a large quantity of food and receive no benefit from it, because it is not of the right kind. He may feed his animals with a large quantity of valuable food, which will be wasted, because it is not of the right kind. In order to feed stock properly, a thorough knowledge of the chemistry and physiology of plants and animals is required.

[A great deal of fault is committed in respect to children by feeding them with the same kinds of food as older persons eat, when their wants are different, and they suffer in two ways, viz.—they do not obtain what they need to cause them to grow, to keep them warm, &c.; and they do eat much more than they ought of, to them, useless food, which annoys the second stomach, and causes disease in it of an aggravated character. When a child does not digest its food, and its stomach seems to receive a large amout of, to it, useless food, two things are to be considered:—1st, if it receive too much of one kind, and not enough of another, or 2d, if it receive too much of all kinds.]

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is probable? ¶ 182. Where is it thought the food produces heat? ¶ 183. Of how many classes is food? When do either of the first become useless? *Inf.*? What

[*The nourishment* of the system must be composed more or less of nitrogen, for that is an element in each of the compounds found in the body except fat.]

[*The fuel* must be composed of substances composed of oxygen, hydrogen, and carbon, but not of nitrogen. These compounds are chiefly —fat (oils, &c.), starch, sugar (honey, molasses, &c.), gums.]

184. *Food may*, secondly, be considered as composed of animal and vegetable food; which include meat, milk, and eggs; nuts, seeds and grains, succulent roots, the twigs and bark of some trees, sap, fruit, leaves and stalks (greens) of plants, and the wood and roots of trees and shrubs.

[Meat is composed of lean, fat, tendinous and nervous substance, and blood. It always contains more or less waste, though but little comparatively. *Lean meat* must be mostly nourishment, and adapted to be eaten in summer, if a sufficient quantity of waste be also taken. The fat must be fuel, and well adapted to cold weather, but not to warm. This is evident from the fact, that animals are fat in the fall and in cold climates, in accordance with our need; and our appetite inclines us to be fond of fat meats in fall—sausages, for instance. Many persons having hearty appetites in summer from *laboring* hard, injure themselves by eating too fatty food. *Milk* is nourishment, fuel and water; whether it contain any waste substance or not is uncertain. A great part of its bulk is water; in this are dissolved the fuel and nourishment. The fuel is fat (butter) and sugar; the rest of the solid portions of the milk may be considered as nourishment. In skim-milk, therefore, there is as much nourishment, but not as much fuel or food to fatten, as in new milk. The same is true of butter-milk. The sugar is the chief heating or fattening ingredient. These are kinds of food which will do well in warm weather, and to cause animals "to grow," but will not be suitable to very young animals, or to cold weather. Cheese must contain much concentrated nourishment. *Eggs* are entirely, except the shell, transformed into the chicken, and must be entirely nourishment, and well adapted to spring and summer, but not so perfectly to fall and winter.]

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fault in respect to food of children is common? Of what must the nourishment be in part composed? Of what the fuel? ¶ 184. How secondly may food be considered? *Meat? Lean meat? Fat? Milk? Eggs? Nuts? Seeds and*

[*Vegetable food.** *Nuts* contain a large amount of oil, and some nourishment, and are well adapted to cold weather. *Seeds and grains* form our breads, puddings, and pastry generally. They contain a large quantity of starch; many of them more or less oil, nutritious substance, and a portion of waste. Some of them are adapted to use all the year; for instance—oats, wheat, &c. (oats are probably the best and cheapest of them all); while some are much better adapted to cold weather; for instance, buckwheat, &c. *Roots.*—Some of the roots contain, for instance the potato, a large amount of starch; also nutriment, and waste. Others, for instance beets, contain sugar, and waste. *The twigs, buds, and bark* of trees contain gum, starch, nourishment in small quantities, and waste substance in large. *Sap* sometimes contains sugar. *Fruit* is very different in different cases: that which is quickly formed in the early part of the season, such as berries, cherries, &c., is composed mostly of water, waste substance, a little nourishment, with scarcely any heating properties. That which is formed more slowly, and comes to maturity later, contains more "substance." The hotter the summer, the sooner do fruits mature, and the more juicy and delicious are they; which is especially true of those brought from tropical climates. Certain fruits, such as peas, beans, &c., approach nearer to being seeds, and contain a great deal of nourishment. The fruits ripening toward fall, contain sometimes sugar, as sweet apples; sometimes starch, sometimes gum, and more or less nutriment. The most conspicuous food in fruits, however, is the waste food, which renders them excellent for summer use, as serving to make up a necessary bulk of food, and should be eaten, no matter what epidemic may prevail.† *The leaves and stalks* of plants are almost entirely nutriment, and waste substance, in the early part of the year, as they should be; for as summer is approaching, the stock of fuel in the system does not need to be increased, but may be drawn upon till exhausted. Toward fall they contain more starch, gum, &c. Yet most of

* Animal food is, in fact, vegetable food, since it was composed by plants.

† One of the most incorrect ideas that has ever been conceived is, that fruit is injurious in summer. It is not the fruit, but the way it is eaten. It should be eaten as nature ripens it, a little at a time when we first use a new kind, not according to the state of the market; and as soon as accustomed to it we may eat abundantly, always noticing that as soon as the weather for a day, or even the half of it, becomes cool, the system requires more of some other food and less of fruit.

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grains? *Roots*? *Fruit*? Of what kinds and when are people apt to eat too

them do all summer long contain more or less of fuel; for the cow obtains the butter she yields, from the grass.* *The wood and roots* of many trees contain more or less of a starchy substance, and a gum, mixed with mucilage, that contains a small portion of nourishment; but these parts of plants, being a framework to the plant, are mostly composed of incompatible waste substance.]

[*Of the various kinds of food*, people are apt to eat too much nourishment summer and winter, and especially when unwell; and in summer, and when unwell, too much fuel; and in summer, too little waste food, which by sedentary persons is used in too small quantity during the winter. Females do not eat enough waste food, as a general thing.]

Sec. 3.—*Air in the production of Heat.*

185. *That air is concerned in the production of heat is proved* by four things. 1st. It is the means by which heat is removed from the body. 2d. We take much more of it into the system in cold than in warm weather. 3d. That which is breathed is more effective in cold than in warm weather. 4th. The air is of such a nature that it can assist in producing heat.

[1st. Since it is by the air that the heat is removed, the air ought to be the means of causing an equal amount to be produced. And as the power to remove heat varies, so ought its ability to produce heat. If this be so all is right.]

[2d. When water or air is cold much more of it is contained in a given space. Hence when we fill the lungs with cold air they receive more than if the air be warm.]

[3d. When the cold air is taken into the lungs it is warmed, and of

* Cabbage is said to contain more nourishment in proportion to its weight when dried than any other plant, and in this respect is probably the most profitable of any thing that can be raised. The effects of Scotch Kale, and Dutch Sourcrout, show that cabbage is not an unhealthy article of food, but probably one of the most healthy on the catalogue. About 30 tons of fresh cabbage can be raised to the acre.

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much? ¶ 185. What proves the action of air in the production of heat? Why

course swelled or expanded, and, therefore, brought more closely in contact with the inner surface of the lungs, and of course will produce a more powerful effect on the blood.]

Exp.—If a person suddenly fill his lungs with cold air and instantly stop his breath and place his hand on his chest, he will perceive his chest to expand, as the inclosed air grows warm.]

[That the air is adapted to produce heat is evident from what we see in the burning of wood.]

186. *How the air acts* is not precisely known.

[Some think that the air unites directly in the lungs with certain parts of the blood, either produced by exercise or obtained from the food, or both, and that thus heat is produced in the lungs. Others think, that the air unites with certain parts of the blood, and with them passes into the various parts of the body, where it leaves those parts of the blood with which it has been united, and by uniting with other substances, derived either from the food or the exercise of the system, heat is thus produced. Others again, and I believe correctly, think that the air in part produces heat by uniting with certain substances in the lungs, and in part by passing with certain other parts of the blood into the parts of the body. In any case, since by the action of the air, heat is produced.]

187. *It is very important, in order that the system be kept warm*, that an abundant supply of pure air be breathed, and night or day-rooms should be perfectly ventilated.

Inf.—Inasmuch as cold air is more productive of heat than warm air it will be preferable.

[There is one exception to this. If a person be of feeble health, so that he cannot produce as much heat as is necessary to warm the cold air received into the lungs, it will be very improper for him to receive it, and *pure* warm air must be inhaled. Feebleness in respect to producing heat also usually exists in infancy and old age.]

188. *In the production of heat, water* must be of essential importance.

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ought the air to produce heat? Why do we receive more cold than warm air? What effect on the air is produced in the lungs? *Exp.?* What does the burning of wood show? ¶ 186. How does the air act? What is thought of the action of the air? ¶ 187. What kind of air should be breathed? *Inf.?* What exception? ¶ 188. Use

[Since it is by the water of the blood that the food, the air, and the substances resulting from exercise are circulated and caused to act on each other, the greater the quantity of the water, the less rapidly will it circulate, of course; and the less the quantity of water, the more rapidly the circulation will take place, and the more or less rapidly will heat be produced.]

Inf. a.—The thirst, by inducing us to drink, is of use in preventing the production of heat.

Inf. b.—The kidneys, by their activity in removing the water, can, of course, be of use by lessening the quantity of water.

CHAPTER II.

Distribution of Heat.

189. Wherever heat may be produced, it is distributed by the circulation of blood.

Inf. a.—Whatever causes the more rapid circulation of blood distributes the heat more rapidly.

Inf. b.—Exercise, rubbing the system, general health, and the removal of the water by the kidneys, will shorten the time required for the blood to pass through its rounds.

Inf. c.—The ill health of any part, which prevents its receiving blood, prevents the distribution of heat to it.

Inf. d.—The drinking of water, freely, lengthens the time during which the blood can run its circuit.

190. *The amount of heat distributed* to any part will depend upon the quantity of blood it receives and the distance of it from the centre.

Inf. a.—All parts will not have the same natural temperature.

Inf. b.—To increase the temperature of a part, we must increase the circulation through it.

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of water? *Inf. a.*? *Inf. b.*? ¶ 189. How is heat distributed? *Inf. a.*? *Inf. b.*? *Inf. c.*? *Inf. d.*? ¶ 190. The heat any part receives depends on what? *Inf. a.*? Do they? *Inf. b.*? ¶ 191. To preserve heat what is necessary? What is said of fat?

CHAPTER III.

Preservation of Heat.

191. *To preserve heat four things are to be noticed*—1st. The fat beneath the skin. 2d. The clothing upon the skin. 3d. The air surrounding us. 4th. The shelter of our buildings.

[1st. That fat is a protection against loss of heat is evident, since we gain a coat of it in fall and lose it in spring, as a general thing. It is also the same with other animals in cold regions. In warm regions the animals do not have the fat. The quantity of fat depends on the need of the animal in respect to the preservation of heat. In case of the swine, the bristles of which are a slight defence, the fat is thick. In case of the whale also, and in case of the infant.]

Inf. a.—The infant requires to have the heat effectually preserved.

Inf. b.—The layer of fat being thick in the fall of the year and preserving heat, a smaller amount of heat need be produced, that is to say, a fat animal is kept on less food than a lean one.

[2d. That fur, hair, wool, feathers, etc., will preserve from loss of heat, need not be argued. All that need be said is, that according to which of these the animal has, so will the kind and quantity of food be which they require.]

Inf.—A cow and sheep do not require the same kind of food.

[3d. The warm atmosphere prevents the escape of heat, and it is for this purpose we should have our rooms warm, rather than for the purpose of warming us. In extraordinary cases a person may go to the fire to receive heat from it, but it is almost always best to have heat produced in the body and preserved in it, rather than received from external sources.]

[4th. The shelter of our buildings saves us from the loss of heat.]

Inf. a.? *Inf. b.?* Do the cow and sheep require the same quantity and kind of food? What effect has the warm atmosphere? How does the shelter of our houses protect from loss of heat? Do we usually strive to keep in the heat or keep out the cold? Which is it? Does a sheep need as warm a stable as the cow? If one protection be ample, do we need the others? Who will need the most clothing, the fat

Inf.—Where one protection is ample we do not need the other, and of course with an abundance of clothing, there is no more danger of taking cold from being out of doors than in the house at any time if the system can warm the air we breathe.

CONCLUSION.

192. If a person wish to keep himself or animals warm, he must observe that a proper quantity of proper food, and drink, and air, and exercise be taken, and that he wear a proper quantity of protective clothing, and from time to time give the system a good rubbing. He must also be especially careful to preserve his general health. If this be not good, he must observe that his chief reliance must be upon clothing and shelter, which, indeed, is a kind of clothing. For if health be not good, neither the food or air can be effectually used by his system in the production of heat, which must therefore be very carefully preserved. When, therefore, by labor, the system has been exhausted, more clothing should be worn. Especially is it important, that more clothing be worn toward night, as the system is exhausted, while the air is usually cooler than during the day, and of course removes heat rapidly.

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person or the lean one? ¶ 192. If a person wish to keep warm, what is necessary?

BOOK II.

The Cooling Process.

193. *The system is cooled by* three means—1st. Rest. 2d. Water. 3d. Air.

[1st. As exercise and the use of food and air tend to produce heat, the disuse must tend to cool the system.]

[2d. Water cools the system not only by its low temperature and by preventing the rapid production and distribution of heat, but more especially by passing through the blood-vessels to the perspiratory glands of the skin, by which it is caused to pass out to the surface of the skin, from which evaporating it cools the body.]

Inf. a.—As by perspiring, the quantity of water in the blood-vessels is constantly lessened, it should be resupplied often, by small draughts; and in case of animals, especially the horse, as well as in case of man.

Inf. b.—That state of the atmosphere which facilitates evaporation will tend to cool the skin.

[When applied to its surface water also cools the skin by conduction and by evaporation]

Inf. a.—Cold vapor in the air abstracts heat from the system.

Inf. b.—If the skin cannot perspire, and the system be hot, washing or sponging the skin with cold water will many times be a valuable means of reducing the temperature to a healthy state.

Inf. c.—If travelling with a horse in warm weather, he ceases to perspire, it will be well to sprinkle a little water upon him.

[3d. The air, by acting upon the skin, abstracts heat, especially if it blow upon the surface, and is a very agreeable means to gently lower the temperature of the system.]

¶ 193. By what means is the body cooled? Effect of want of exercise and food? How does water cool the system? *Inf. a?* *Inf. b.?* What states of the air facilitate

ADDENDA TO PART II.

[SEC. A.—*Organic or Involuntary Nervous System.*—It is very evident to the scholar, that there ought to be some means of harmonizing the action of the parts thus far described, and causing them to increase or diminish their action in accordance with the best good of any other part and of the whole. Precisely how this is accomplished, we cannot say, but it is done in the most admirable manner. The supposition is, that there is some nervous centre or centres upon which all parts of the body can produce effects according to their conditions, and from which effects are produced upon all parts, as need may be. The efficiency with which these influences are exerted depends upon the constitution of a person, his health, and the strength or exhaustion of his system by fatigue, watching, etc. Hence, one person cannot do without injury, what another may do with impunity. A person cannot at one time do what he may at another.*]

[How this nervous system operates, no one knows, nor do we certainly know through what channels it operates. It is of vast importance in the animal economy, and when it cannot exert a vigorous influence, a person must be very careful of exposure. Its powers are exhausted by continued mental or physical labor, and in a very striking manner by the action of certain diseases, and by the continued effects of heat and cold.

[SEC. B.—*The Sympathetic Nervous System.*—Upon each side of the spinal column, at short distances, are found small collections, called ganglia, of reddish-gray nervous substance. These are connected by small white cords. From these, small branches extend off on the arteries, and by some are supposed to extend to their very extremities. Branches also extend into certain parts of the skull,

* These things show the utter absurdity of those who would apply the same kind of remedies to all kinds of complaints, and the ignorance of those who would "doctor the symptoms" or signs of disease, without thoroughly investigating the cause and condition.

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evapofation? What ought there to be in the system? What is the supposition in respect to the nervous system of organic life? The efficiency of the organic nervous influences depends on what? Can all persons do the same things wih impunity? What is the foot note? What is the result when the nervous system of organic life cannot exert a powerful influence? How are its powers exhausted? What is said of the

where also certain of the ganglia are found. For what this arrangement is, no one certainly knows. By some it is regarded as the means by which the involuntary nervous influences are exerted.]

[SEC. C.—*The Spleen* is a part of the body about as large as a kidney, found just at the left of the stomach. It is called the milt commonly. It contains a great quantity of blood. Its use is not known.]

[SEC. D.—The Thyroid and Thymous Glands, and Renal Capsules, are parts of small size, the use of which is unknown.]

[SEC. E.—*The Lymphatics* are the names of tubes, commencing in nearly all parts of the system. They are small in size, having a beaded appearance, extending in nearly parallel lines from the extremities toward the centre of the body, and at last opening into the lacteals or thoracic duct, or into the veins. They contain a limpid fluid of a watery color, called lymph. Their use is not known with certainty.]

[All these organs of Part II together, may form a class which may be called the second class.]

REVIEW OF PART II.

[We may now review and present at once before our minds the uses of food, air, and water, and reconsider what organs are necessary to apply them to their uses.]

The welfare of the system requires that four duties be fulfilled. 1st. Excretion. 2d. Nutrition. 3d. Heating. 4th. Cooling.

Food is useful as nutriment and fuel.

Air is useful in excretion, heating, (and perhaps in causing those changes which are connected with the action of the system,) and in cooling.

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sympathetic or ganglionic nervous system? What is said of the spleen? What is said of the thyroid, etc., glands? What is said of the lymphatics? What does the welfare of the system require? How is food useful? How is air useful? How is water

Water is useful as a vehicle to receive and transport from one place to another, any substance to be excreted, to nourish, or to heat the system. It distributes heat, and thus warms some and cools other organs. By its presence it dilutes the nourishment, and renders the nourishment of the system more slow; while by its removal the nourishment is furnished to the system more rapidly. By its presence it prevents the production of heat, by diluting the fuel of the blood. By its removal it increases the rapidity with which heat is produced, and also with which it is distributed. If perspired, it by evaporation cools the body, as it does also by application either as a bath, or in the form of "damp cold air." By its removal it also increases the rapidity with which excretion is produced.

Five classes of organs are necessary to make use of the food, air, and water. 1st. The Excreting. 2d. The Digestive. 3d. The Respiratory. 4th. The Circulatory. 5th. The Nervous System of Organic Life.

The Excreting Organs are of five classes. 1st. The Lungs. 2d. The Kidneys. 3d. The Skin. 4th. The Liver. 5th. The Second Stomach and Colon.

The Digestive Organs are, 1st. The Mouth. 2d. The Stomach. 3d. The Second Stomach, Liver, and Pancreas. 4th. The Lacteals.

The Respiratory Organs consist of the Lungs, and apparatus which inspires and expels the air from them.

The Circulatory Organs are the right and left Hearts, the Arteries, Veins, and Capillaries.

The Nervous System of Organic Life is indefinitely known.

[The uses of each organ, and the necessity for its existence, will be

useful? What classes of organs are necessary to make use of the food, air, and water? How many and what class of organs compose the excreting organs? How many and what organs compose the digestive organs? Of what organs do the respiratory apparatus consist? What are the circulatory organs? What organs are required in the

more strongly impressed if they be now classed according to their use in fulfilling the grand duties of the system.]

In the process of excretion there are required, the Lungs, the Kidneys, the Skin, the Liver, the Second Stomach and Colon, the Hearts and Blood-vessels, and the Nervous System.

In the process of nutrition there are required, the Mouth, Stomach, Second Stomach, Liver and Pancreas, the Lacteals, the Kidneys, the Hearts and Blood-vessels, the Nervous System.

In the process of keeping the system warm there are required, the Mouth, the Stomach, the Second Stomach, Liver and Pancreas, the Lacteals, the Lungs, the Kidneys, the Hearts and Blood-vessels, the Nervous System.

In the process of cooling, there are required the Skin, the Lungs, the Liver, the Blood-vessels, the Nervous System.

[The duty of the Lungs is therefore three-fold.
The duty of the Kidneys is also three-fold.
The duty of the Skin is two-fold.
The duty of the Liver is four-fold.
The duty of the Second Stomach is three-fold.
The duty of the Mouth is two-fold.
The duty of the Stomach is two-fold.
The duty of the Lacteals is two-fold.
The duty of the Hearts and Blood-vessels is four-fold.
The duty of the Nervous System is four-fold.]

[The duties just mentioned have reference merely to the action of each organ in respect to the four grand duties of these organs.]

All the organs engaged in excretion, nutrition, and in heating and cooling the system, may very properly be combined into one class, and called the Second Class of Organs.

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process of excretion? What organs are required in the process of digestion? What organs are required in the process of keeping the system warm? What organs are required in the process of cooling the system? How many duties have the lungs? *What are they?* How many duties have the kidneys? *What are they?* How many duties has the skin? *What are they?* How many duties has the liver? *What are they?* How many duties has the second stomach? *What are they?* How many duties has the mouth? *What are they?* How many duties has the stomach? *What are they?* How many duties have the lacteals? *What are they?* How many duties have the hearts and blood-vessels? *What art they?* How many

[They are frequently termed the organs of organic or vegetative life.]

[It is now worthy of notice, that as the first class is dependent on the second for nourishment, &c., so also the second class is dependent on the first for supplies of food, clothing, water, &c. Hence they are most intimately connected by means of their nervous systems, and every state of either has an effect upon the other; the mind also is so connected with the body, that every state of the mind affects more or less immediately all parts of the system, and the fulfilment of every duty of the second class of organs, while every state of those produces an effect on the mind. A person cannot then expect good digestion when his temper is morose, and on the other hand, indigestion will tend to produce a bad state of mind.]

[One fact more is here worthy of notice, viz., all parts of the body increase in size from the earliest periods of their life to mature years. For the accomplishment of this it is evident that such substance as the body is composed of will be required, viz., the same substance as is necessary in the repairing process. It must be prepared, and in all respects treated in the same manner.]

The nourishment of the body previous to maturity is for two purposes. 1st. Its growth. 2d. Its repair.

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duties has the nervous system of organic life? *What are they?* What organs may be brought into one class? What may it be called? What are the organs composing it frequently called? What is now worthy of notice? How are the two classes of organs in the body connected? What cannot a person expect? What fact is worthy of notice? What is necessary for the growth of the system? For what is nourishment of the body previous to mature years? *What do you suppose causes the body to grow for a series of years, and then cease to do so?* What now are we prepared to do?

PART III.

CONNECTION BETWEEN THE FIRST AND SECOND CLASS OF ORGANS AND BETWEEN THE MIND AND THE WHOLE BODY.

194. *Nothing can be more intimate, powerful,* or important, than the relation which exists between the first and second class of organs, and between the mind and the whole body.

Illus. a.—Anger flushes the cheek; fear makes us grow pale and quiver.

Illus. b.—Dr. Beaumont testifies, that the process of digestion would sometimes stop for an entire hour, in case of St. Martin becoming angry.

Illus. c.—A melancholy state of mind tends to produce disease.

Illus. d.—Pity, joy, and grief, will cause the tears to flow.

Illus. e.—The thought of delicious food causes the saliva to flow; and Dr. Beaumont testifies, that the same cause would produce a flow of the gastric juice.

[Indeed, by more illustrations than our space will allow, it might be shown, that the mind will act as an emetic, a cathartic, a sedative, a stimulant, an astringent, an alterative, a producer of disease or of health; in short, when powerfully active, will prolong or shorten life.]

Inf. a.—For health's sake, we should always strive to cultivate an amiable and lively state of the disposition.

Inf. b.—We should cast off, as far as possible, all thoughts of disease and every thing else which will make the mind anxious or worried; and when unwell we should, as one of the most powerful means of cure, produce a pleasant state of mind.

Inf. c.—When sick, an excited state of the mind should always be avoided, and every thing be done which shall give the patient confidence

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¶ 194. Is the connection of mind and body intimate? *Illus. a.*? *Illus. b.*? *Illus. c.*? *Illus. d.*? *Illus. e.*? How may the mind act? *Inf. a.*? *Inf. b.*? *Inf. c.*?

in his restoration. Strangers and visitors should not be allowed to exhibit their kindness, etc.

Inf. d.—If an individual fear he is unwell, let him at once either cast it out of his mind, as one of the best curatives he can use, or let him go to an honest, intelligent, highly educated man, who can tell him whether there is any ground for his fears, and if there are, how his disease is to be removed, if it can be.

[There is nothing worse than continually thinking what a person shall eat, and what he shall drink, etc., etc., with which so many people engross their attention. No kind of food will produce dyspepsia so soon as thus dwelling on one's diseases, food, etc. Better, therefore, eat unwholesome food, than dwell too long on such matters. We should inform ourselves well upon these points of course, and use the dictates of common sense, and if we have any doubts, ask such persons as would be likely to know, but throw the subject off our minds quickly, and give attention to something of a more healthful character.]

Illus. f.—If a portion of food too much be taken, the mind feels heavy and dull, disinclined to effort.

Illus. g.—If the skin be not bathed, the action of the mind will not be vigorous.

Illus. h.—If disease exist in any part, it is prone to exert a powerful influence on the mind.

Inf. e.—It will be of the highest account that a state of perfect health be preserved in all parts of the system, in order that mental activity may be at its height.

Inf. f.—A student is never wasting time who is engaged in producing or perfecting, or saving his health.

Inf. g.—The merchant is gaining time when he spends it in improving his bodily health.

CONCLUSION.

It is clearly proved that the cultivation of the intellect and disposition, in a proper manner and to a proper degree, improves health, adds beauty to strength, and increases the happiness of man, while it lengthens his days; and on the other hand, paying proper attention to the welfare of the body, not only gives it health, but tends to produce as well, a healthy and happiness-causing state of the intellect and disposition; while proper attention to mind and body, in accordance with the intentions of our Creator, makes us men in the true sense of the term, and enables us to enjoy the rich blessings of this world with which God in his goodness has so abundantly surrounded us.

Inf. d.? What is said to be very bad? *Illus. f.*? *Illus. g.*? *Illus. h.*? *Inf. e.*? *Inf. f.*? *Inf. g.*? What is the conclusion?

APPENDIX.

ACCIDENTS, DROWNING, CHOKING, POISONING, QUACK MEDICINES, &c.

A.—BLEEDING.

Two things are to be noticed—1st. How we are to know if the bleeding be dangerous. 2d. How to stop it. 1st. Bleeding from the systemic veins is rarely dangerous. The blood that flows in this case, is of a dark red color. The flow will be rather uniform, not in jets, though it may for a few moments be very rapid. Bleeding from any of the large systemic arteries will quickly destroy life. If from the small arteries, it is frequently dangerous. It is known by the bright red color of the blood, and especially by the jetting of the flow. It likewise seems to come from towards the heart. Usually the wound which injures an artery must be a severe one. Sometimes, however, the flow which takes place after leeches have been applied, has destroyed life, especially in case of children. Sometimes, also, from a slight wound, particularly in the region of the temples, the flow has caused the loss of life. If leeches be applied, or a wound occur in the evening, at least in case of a child, notice should be taken of the state of things, and those who have the care of it should not retire to sleep without every thing is safe. In case of bleeding from the nose, it rarely happens that a blood-vessel is broken, but the flow is caused by the oozing of the blood, so to speak, through the lining of the nose. It is very delicate, and plentifully supplied with blood-vessels. When these become overloaded, their contents sometimes discharge themselves as above said. This is not dangerous unless too frequent or prolonged. Often it is very advantageous.

2d. To stop the flow of blood, it is evident the part which is bleeding should be held as high above the heart as possible, as its action will then be less effective.

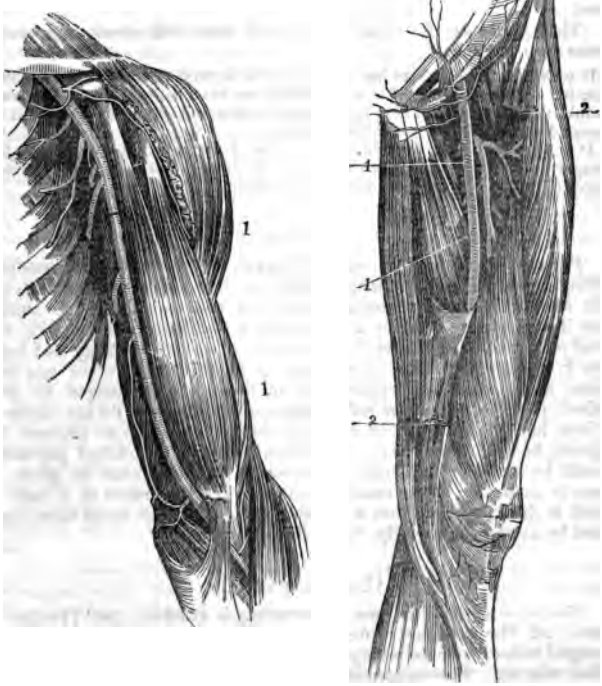
Illus.—When the nose is bleeding, the flow is increased if the head be held down.

When, therefore, the arm or hand is injured, it should be thrust upward as far as possible. If the lower extremities be injured, and blood flowing too freely, a person should lie down and thrust the foot upward

as far as possible. In the next place, it is to be noticed that the blood which flows to either of the extremities is chiefly contained in one vessel at certain places, as in fig. A and B. 1 1, represents the large artery through which the parts below are supplied.

If pressure be made upon these vessels, and the flow of blood through them stopped, it must cease from the parts below. The situation of the vessels is therefore to be accurately noticed. It will be observed, in case of the arm, that the artery is near by the inner edge of the large muscle on the front part of the arm. In case of the leg, the artery is

A. B.



found between the inner edge of the sartorius muscle, 2 2, a piece of which has been removed. (See also 62, Pl. 1, fig. 1.)

If we would make efficient pressure upon these vessels, it is necessary that it should be so made, that the blood-vessel should be between the cause of pressure and the bone.

Sometimes by grasping the limb tightly, with the vessel between the ends of the fingers and the bone, the flow can be stopped. A handkerchief or other strong bandage may be used, after twisting it and tying a knot in the centre. This must be so placed that the vessel is between it and the bone. The ends are then to be carried round the limb, and tied in such a manner that a stick or the like may be passed under the bandage directly opposite the knot, and made to twist the bandage till the knot shall forcibly press upon the artery. To aid in this, something not very large may be placed under the knot.

Continued pressure directly on the wound will sometimes stop the flow.

The application for some time of cold water will check and sometimes stop the flow.

If an artery of any size has been injured, it must be tied, as the expression is. If the flow stop for a short time, or even several hours, a person should not be satisfied till a ligature has been put upon it, except it be deemed unnecessary by a skillful surgeon.

It is also worthy of notice, that in case of an injury to an artery, the danger is imminent, and something must be done at once, and by a person himself, or the by-standers, while the surgeon is sent for.

B.—FITS.

Persons are sometimes suddenly taken ill, and become insensible, falling down, sometimes remaining stiff in their seats, sometimes lying still after falling, and sometimes twitching and convulsing. In such a case it will be best to place a person in a reclining position, with the head elevated. Let him receive fresh air, loosen his clothing, and keep him from currents of air. If his hands or feet feel cold, cover and rub them, and make warm applications to them. If the person be convulsed, place him upon the softest convenient thing, and do not attempt to hold him more tightly or carefully than is necessary to prevent his injuring himself or any one. Meantime, of course, the skilful physician should be sent for; and until he advises it, nothing should be given or done in particular, as the causes of the evil and the nature of it vary so much in different cases, that a person is apt to do much more harm than good by attempting to help the suffering person.

C.—DROWNING.

The cause of death in case of drowning is twofold: 1st. The loss of heat. 2d. The exclusion of fresh air from the lungs. When a person is plunged under water the windpipe is at once closed, and of course remains filled with air. The oxygen of this is however quickly exhausted, and

it is fully loaded with substance received from the blood. The impurities which should leave the body by way of the lungs, now quickly accumulate and become deadly poison to the brain and nervous system, the action of which immediately ceases, and returns no more except the person is resuscitated. The time after immersion during which this may be done depends on many circumstances, but chiefly on the warmth of the water and character of the clothing. The colder the water, the sooner is a person past recovery. But, till long after the surface is quite cold, we should not cease our exertions.

The first thing to be done, is to carry the drowned quickly and gently to the most convenient place. Put him in a reclining posture, with the head slightly elevated. The second thing to notice, is the importance of preserving what heat is left, and if possible adding to it. At once the wet clothes are to be removed, and the person wrapped in flannels. If they are warm or quite hot, so much the better. Something warm should be put to the feet especially. If no fire is to be had, one or two persons should lie by the side of the drowned, that he may be warmed by the heat of their bodies. The third thing to be noticed is, that the poison must be removed from the blood. For this purpose we must bring the pure air to act in the lungs. As they are already more or less filled with bad air, the first thing is, to cause it to be expelled. This is done by pressing gently but forcibly upon the sides and front of the chest and abdomen. Next, we desire to have fresh air pass into the lungs. This may be done by first pressing the upper part of the windpipe downward and backward. The object of this is to keep the windpipe open for the inward passage of the air, which will be produced by removing the pressure made upon the chest and abdomen. The cartilages of the ribs and back, owing to their elasticity, cause the sides of the chest to spring upward and outward, and the inward pressure of the air fills the lungs. Sometimes, however, the inward passage of the air, or some cause, closes the upper part of the pipe. This is recognized by the chest not expanding. In this case the windpipe must be opened. This is done by drawing the skin tightly across it by means of the thumb and finger, which, also, by the same act, hold it firmly. Then cut into it about half an inch below the prominence of the throat, ordinarily called Adam's apple. The opening should be made large enough to insert a tube. For this a quill serves a very good purpose. If no tube be convenient, the sides of the opening made should be spread so as to allow the air to pass freely.

When this part of the process is attended with success, the artificial breathing should be continued a long time, even if no signs of life are seen.

The pressure should be made and removed about twice as often as a person ordinarily breathes. The pressure should be gradually increased and somewhat prolonged, and almost suddenly removed.

The next thing to be noticed is, that if we remove all the poison from the blood in the lungs, this does not affect the blood in the brain or other parts of the body, except the circulation of the blood be produced,

Rubbing, therefore, of the surface is also to be done, but in such a way as not to cool the person at all.

Lastly, we must notice, that nothing but evil would result from the use of bellows, or from blowing in a person's mouth, &c., &c.

D.—CHOKING.

In case of choking which is immediately dangerous, it is usually owing to the stoppage of the food in the upper part of the throat, on account of which the windpipe is convulsively closed, and the air being prevented from entering the lungs, the person dies from the same cause as in case of drowning. If any thing be elsewhere detained in its passage from the mouth to the stomach, there is usually time to send for the surgeon. If death is about to occur, because from any reason air is not received by the lungs, the same course must be pursued as in case of drowning. The effort to press the windpipe downward and backward is to be made. If this be unsuccessful, the windpipe must be opened. Sometimes a smart slap on the shoulders will be sufficient to dislodge the offending cause.

It can usually be determined, that the want of air is the cause of death by the livid color of the lips and whole face, and the various signs of suffocation exhibited.

E.—POISONING.

Poisons may either be introduced into the system from without or generated within, as we have seen; poisons of a peculiar character also seem, under some circumstances, to be produced by disease. Poisons ordinarily derived from external sources may enter the system by the way of the skin, lungs, or stomach. In the first place, they should be excluded. 2d. Neutralized. 3d. Diluted. 4th. Evacuated. 5th. Their effects mollified. 1st. They may be excluded by our being able to recognize them, and under what circumstances they exist. This work is too small to teach this knowledge. As far as possible, however, every child should be early taught to know and avoid that which is noxious to his system. Again, it is evident, that if the vessels of the body be full, they cannot and will not readily receive from the air or any source poisons, which would be received with avidity by the vessels if partially filled. Hence, when about to be exposed by necessity to the deleterious air of a sick chamber, or elsewhere, it is frequently well to drink freely of pure water.

2d. There are many things which partially or wholly tend to neutralize in part or wholly the harmful action of certain poisons. But as they would be usually not at hand, and perhaps also not easily remembered, one thing only will be mentioned—eggs should be swallowed as quickly as possible after too large a quantity of corrosive sublimate has been taken. This poison is the usual prominent ingredient of bug

poisons. It is so deadly, it should not on any account be kept in any part of a house, but obtained merely as it is wanted.

3d. Almost all liquid poisons may be diluted by water, which should be swallowed in the greatest quantity and very rapidly. This will dilute the poison, distend the stomach, and assist in vomiting or cause it.

4th. To evacuate the poison, whether it have been neutralized or diluted, or not, is almost always quite necessary. If the poison have been dissolved, this is usually readily done. But if the poison be a powder or the like, it is apt to adhere to the sides of the stomach. In this case we wish to distend the stomach, so that no poison may be detained in any folds of it, and in the second place, to pass into the stomach some paste-like or adhesive substance, which, by adhering to the poison, shall bring it out. In such a case, therefore, it is best to stir up a portion of flour or meal in a pint or quart of water till it is thick as a person can swallow. This he should swallow. If no meal be at hand, water alone may be taken. To act as an emetic, let a person swallow a tablespoonful of ground or pounded mustard—it may be by itself or stirred in water. If this be not at hand, let a person drink of water as fast as possible till the stomach is overloaded, when the water will usually act as an emetic. If it can be had, sulphate of zinc in small quantity will act as an emetic. Many other things will also. According as they are most convenient they can be used. Sometimes the poison, especially if a narcotic, has so acted on the system that a person cannot swallow, or if he can, that an emetic cannot operate. In this case it usually happens that the brain is oppressed by the presence of too much blood. To remove this, several things may be done. In case of intoxication, the usual custom has been to pump cold water on the head. Warm applications may also be made to the hands and feet. The system may be rubbed. The person may, if possible, be compelled to take exercise, by placing him between two persons and walking him up and down, cold cloths being upon his head at the same time. Tingling the skin with a switch is also resorted to. Doses of strong tea and coffee are given. Such remedies should, however, be administered with much care, and never by an unskilful person, for if the person could barely live as it is, the slightest increase of the evil might destroy his life.

F.—QUACKERY AND QUACK MEDICINES.

These might very properly be considered under the head of poisons, for they are so in a double sense. Many, yes, thousands have been carried to a premature grave by tampering with medicines, presented before them by the bland voice of the wolf in sheep's clothing. In the second place, the morals of the undiscerning young are undermined by the exhibition of wealth and apparent success, as it is called, of those who laugh at the credulity of their beguiled victims. This most heinous, dishonorable, and wicked traffic in the love of life and family, which is at present carried on in community, ought to meet the severest condemnation from

every moral, religious, intelligent, or well-wishing member of society, If what the quack says be true, then how fiendish to keep secret that which is capable of so greatly blessing man. If it be not true, how vile is he to seduce with baseless promises, till the hour when a cure might have been effected, has past. It often happens, that the evil which could have been nipped in the bud, grows apace by delay. It is not merely tricking a man of his money by false pretences, but it is selling his life, his health, for a few paltry shillings, and selling a life that is not only dearly prized by the possessor, but by, perhaps, a whole family, clinging around him with their affections not only, but depending upon his love for a support and a standing in society. Say not, then, if a medicine should be so inert or so small in quantity, that it does no good, it can do no harm. Let no quack pacify his conscience, if he have any, with such an excuse, for his ill-gotten gains.

But say persons, do we not see people really get well, and of serious diseases too, by the use of what are called quack medicines, and under the direction of quacks? This is true. But here are reasons—1st. A large majority of persons will ultimately get well without any assistance from outward sources. There is a power in the system of every person which tends to cure, and will often succeed. Medicine and judicious medical treatment will assist in hastening the cure of many cases of disease, but the number really saved from the grave, compared with the whole, is very small. 2d. One of the most powerful agents in producing or curing disease, is the mind. Indeed it is, except in few cases, very much the most effectual agent. The mere belief in the efficacy of a course of treatment, will often remove the worst of maladies. This, however, does not make it any the less dishonest for the quack to practise his nefarious arts. 3d. Most of the medicines used and sold or courses pursued, do have more or less of active properties, which are almost, of course, adapted to some cases of disease, few or many. They are sold, or the treatment is applied to all who can be induced to rely on them. The cure of some persons is therefore really hastened or produced, and testimonials of these are gathered up from every section, together with many forgeries, in many instances, and posted before the public, while the failures are very carefully withheld.

4th. Many unprincipled persons who know how to apply medicines with some skill, will pretend (as I have myself seen) to be practising a course or system, when, in fact, they are not, but are giving medicines adapted to the case under a false name; and I have known persons to speak against that which was curing them, and which they were using, but did not know it.

If these things which are told of medicines, or of what are called systems, were really true, could it be possible that persons would be at so much expense and trouble in advertising their wares and cures? If a person had medicine which would always or even often cure consumption, or could always cure scarlet fever, if he were so inhumane as to keep how he did it a secret, would it be necessary for him to trouble himself about money? Could not he go to a hospital, and by a few cures have his name celebrated throughout the country, so that money would pour

in upon him in countless measure? So, also, if those ignorant persons who impose on the still less intelligent, by pretending to *see* the color of the organs in the body, and the disease which affects them, believed what they tell us, would they take the course they do, or would they take a course which would not only be honorable, but secure to them untold wealth, the still more valuable love of a grateful public, and hand down their names to a never-ending future? What shall be done with such base impostors, who waylay the unwary invalid in his search for health, and who is suffering too much to discern between him who truly sympathizes with misfortunes and the artful inhuman who wishes to prey upon them, and who, with hypocritical face, laughs in his sleeve as he hears his mistaken victim lavish gratitude upon his pretended benefactor? What shall be done? Why should not the laws of the country, against obtaining money under false pretences, be brought to bear on them? Why should the lesser offender, and certainly the more honorable, be branded with ignominy, and incarcerated in prison, justly shut out from society, while the more artful and greater curse goes at large and is unwhipped of justice?

How shall we know a quack from an impostor? In the same manner as we would in any other case. I have heard and read these things in respect to a good physician. 1st. It is necessary that he be an honest man. 2d. He should possess, at least, good natural talent. 3d. He should obtain as good a general education as is possible for him—(if he be honest, he will). 4th. He should qualify himself as thoroughly as possible, by acquiring a knowledge of anatomy, physiology, pathology, the effect of every thing in nature (as far as possible) upon health and disease, the experience of others, and he must himself be experienced by the observation of disease. 5th. He should have the highest regard for every good institution of society, and should be, in the strictest sense of the word, at least a moral man. 6th. Thus qualified by natural and acquired talents, he is to visit the sick bed, and without regard to his own case, but with the strongest desire to do his patient good, he is to assiduously inquire into the nature and cause of the evil which exists, and then, taking all the circumstances into judicious consideration, he is to do whatever and use whatever he thinks will be for the good of the sick person. If he be at a loss what to do, it is his duty to call in good counsel, that other thoughts and other experience may, if possible, assist in the difficulty. 7th. Having thus faithfully fulfilled his duty, he will take into consideration the worldly circumstances of his patient, and charge a reasonable sum for the services he has dutifully rendered, always being moderate rather than otherwise, since, in a measure, it may be said, that necessity compelled his patient to call him. While, on the other hand, he will never make his compensation depend on the cure of the man, for it is not his duty to cure, but to do all that lies in his power to effect it.

THE END.

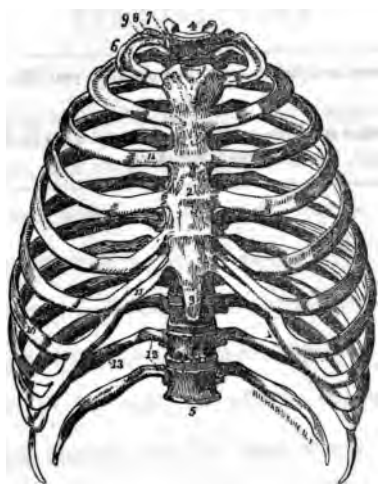
PICTORIAL

ANATOMY.

BY

T. S. LAMBERT, M. D.,

AUTHOR OF FIRST, SECOND, AND THIRD BOOKS ON PHYSIOLOGY, ETC.



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INTRODUCTION

In the following pages, the pictures so well represent the bones of the system, that there is little else to be done but to give the names, composition, and uses of the various parts. In this place it is the intention to give the names only. The composition and uses may be learned from various sources. Particular questions upon each page are unnecessary, since the same are applicable to all the parts. To wit, the scholar may first be asked, or ask himself,—1st, The color of any part. 2d, The form. 3d, The size. 4th, The kind of surface (smooth or rough). 5th, Its weight. 6th, Structure. 7th, Composition. 8th, What it contains (if any thing). 9th, Where situated. 10th, With what connected. 11th, How (movably or immov-

ably). 12th, Uses. 13th, The most noticeable things by which it is able to fulfil, or prevented from fulfilling its duties. 14th, Illustrations.

These questions may be asked, not only in respect to a whole, but of each part; and thus a child will not only learn the character of objects in a scientific manner, but easily learn to give complete, thorough, and direct descriptions.

PICTORIAL ANATOMY.

Fig. 1.

External surface of the occipital (back) bone of the head, (see also fig. 16, where 11 corresponds with 5 in this fig.). 5, Foramen magnum, (great hole). 6, Right condyle, (by this the skull rests upon and is joined to the back bone). 1, 2, 3, 4, ridges and protuberances (easily felt).

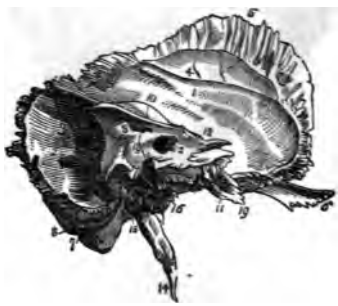
Fig. 2.

Internal surface of the occipital bone. 7, Foramen magnum. 3, 4, 5, 6, grooved ridges (in which are partially lodged certain veins called sinuses, and to which are attached those divisions called falx and tentorium.

Fig. 3.

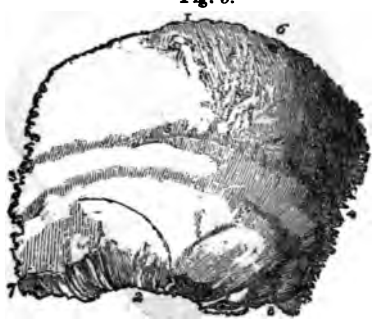
External surface of the temporal bone. 1, Squamous (scale-like) portion. 2. Mastoid portion. 11, Styloid (pen-like) process. 4, Zygomatic (yoke) process. 9, Meatus auditorious externus (external auditory opening).

Fig. 4.



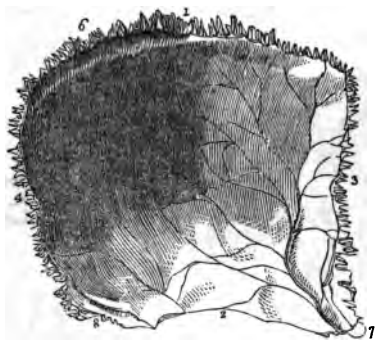
Internal surface of the temporal bone. 1. Squamous, 2. Mastoid, 3. Petrous (rocky from hardness) portions. 14. Styloid process. 5. Bevelled edge (overlapping 2 of fig. 5). This bone is very uneven, has many grooves and foramina.

Fig. 5.



External surface of the parietal (wall) bone (see 14, fig. 15). 1, Superior border, (found at the upper central line of the head).

Fig. 6.

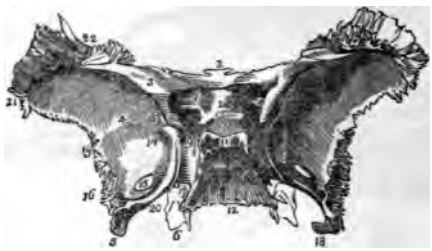


Inner surface of parietal bone (grooves for blood-vessels).

Fig. 7.

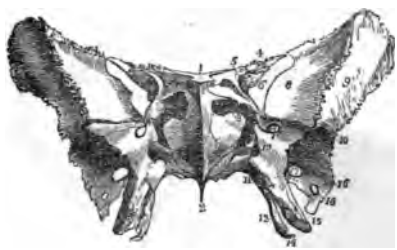
Internal surface of os frontis (frontal bone). 1, Grooved ridge (for sinus and attachment of falx). 5, Orbital plate (helps form the orbit or socket of eye). 11, Opening into frontal sinus, (a cavity in the bone back of the eyebrows of most men).

Fig. 8.



Internal surface of the sphenoid (wedge-like) bone. 21, 22, Greater; 5, Lesser wing.

Fig. 9.

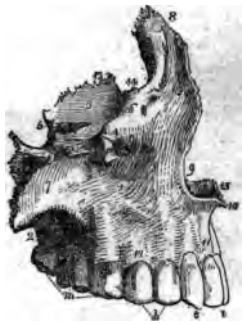


External surface of sphenoid. (It is situated at the base of the skull directly in front of the lower portion of the occipital).

Fig. 10.

The ethmoid (sieve), seen from above and behind. 1, Central lamella. 4, Root of the nose (with holes for olfactory nerves). 8, Crista galli process (comb of fowl). 6, Superior; 7, Inferior turbinated (coiled) bones. 8, Os planum (smooth),) assists in forming the socket).

Fig. 11.



External surface of superior maxillary bone (jaw). 9, Nasal cavity. 8. Orbital surface. 7, Malar (cheek) process.

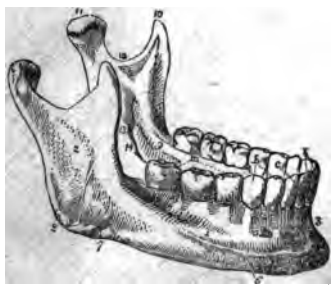
Fig. 12.

Posterior (back) view of the right palate bone. 1, Floor, 2, The wall of the back part of the nasal canal. 4, Portion which joins its fellow of the left nostril.

Fig. 13.

Side view of the palate bone. It is naturally in contact with the inside of fig. 11, as if it should be pushed up behind it as it now stands.

Fig. 14.

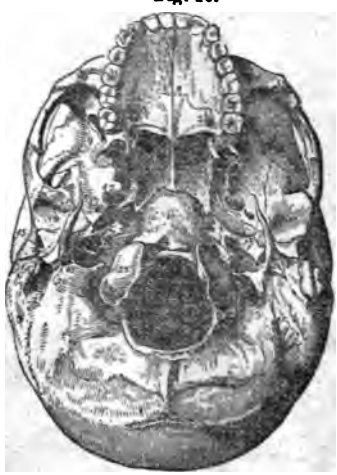


Inferior maxillary. 1, Body. 2, Ramus (branch). 8, Angle. 10, Coronoid process. 11, Condyle. 12, Sigmoid notch.

Fig. 15.

Front and side view of the head. 1, Os frontis. 14, Parietal. 18, Ala (wing) of sphenoid. 16, Temporal. 10, Malar. 7, Lachrymal (tear), also called unguis (nail), from its resembling a nail. 8, Vomer. (Just below 2, the two bones called nasal, form the bridge of the nose).

Fig. 16.

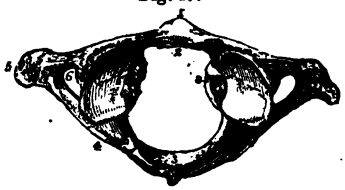


Inferior or basilar surface of the skull. 11, Foramen magnum. 22, Condyle.

The parts of the body thus far surveyed, number 54, viz. :

Occipital,	1		
Frontal,	1		
Parietal,	2	Cranium,	8
Temporal,	2		
Sphenoid,	1		
Ethmoid,	1		
Superior Maxillary,	2		
Nasal,	2		
Lachrymal,	2		
Malar,	2	Face,	14
Palatine,	2		
Inferior Turbinated,	2		
Vomer,	1		
Inferior Maxillary,	1		
First set,	20	Teeth,	32
Second set,	12		
			54

Fig. 17.

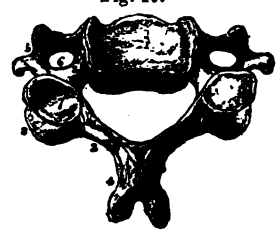


Atlas, viewed from above, (upper vertebra of the back and upon which the head rests). 1, Spinous process. 5, Lateral process. 7, The articular surface upon which the condyle 6 and 22, figs. 1 and 16, rests. 8, Portion in front of 8, fig. 18.

Fig. 18.

Axis (second vertebra viewed from the side). 2, 3, Odontoid (tooth) process, (it passes up through the front part of the foramen magnum of the atlas. It is held in its place by a ligament which passes across from side to side of the atlas, just below 2, fig. 18, if placed in its natural position. Also by ligaments which pass from its upper point to the places on the occipital indicated by 12.

Fig. 19.

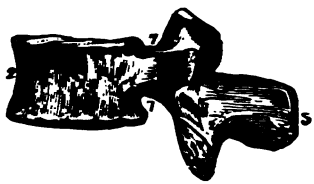


Middle cervical (neck) vertebra, from above.

Fig. 20.

Dorsal (back) vertebra.

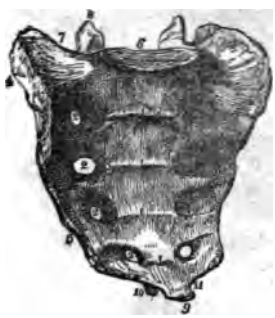
Fig. 21.



Lumbar (loins) vertebra.

Cervical vertebræ,	7	Spinal Column,	24 bones.
Dorsal do.	12		
Lumbar do.	5		

Fig. 22.

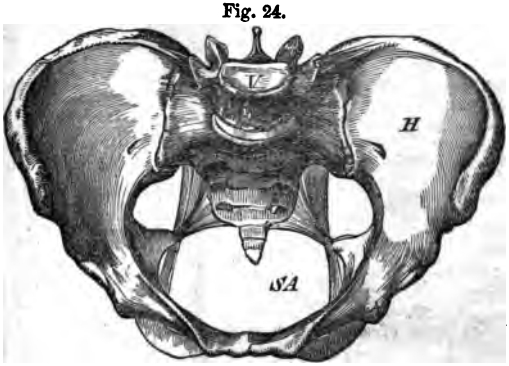


Sacrum (sacred), seen in front. 8, Articulating (jointing) process. 6, Surface corresponding to the body of the lower lumbar vertebra. 9, Process of articulation, with the first of four small bones, called coccyges (cuckoo's bill).

Fig. 23.

ight os innominata
neless) viewed extern-
(hip bone). 1, Ileum.
chium. 3, Pubis. 4,
t of ileum. 8, Ante-
superior, 9, Anterior
ior, 10, Posterior su-
or, 11, Posterior infe-
spinous processes of
ileum. 15, Tuberosity
he ischium. 18, Ra-
of the pubis. 20,
abulum (cup), socket
ie hip bone.

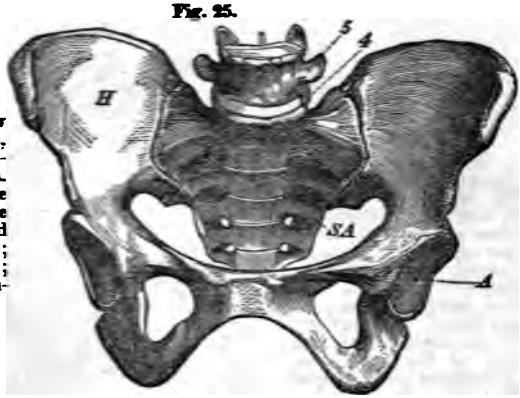
Fig. 24.



ront view of the pelvis, viewed from above. V, Lower lumbar ver-
a. SA, Sacrum—terminated by the coccyx. H, Hip bone.

Sacrum,	1	Pelvis, 7
Coccyges,	4	
Ossa Innominata,	2	

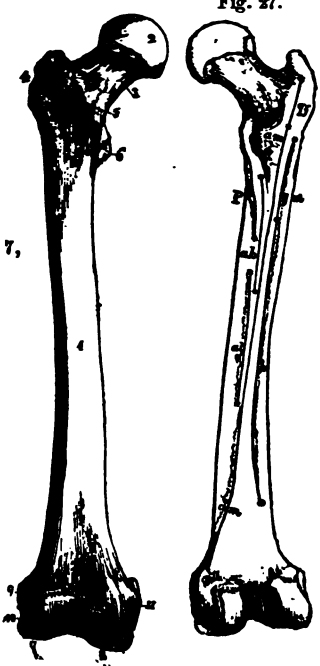
Fig. 25.



Front view of pelvis. 5, Lower lumbar vertebra. 4, Cartilage between the vertebra and sacrum, SA; H, Hip bone; A, Acetabulum.

Fig. 26.

Fig. 27.



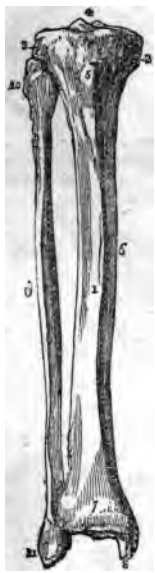
26.

Right femur (thigh bone), seen in front. 1, Body or shaft. 2. Head. 3, Neck. 4, Trochanter major. 6, Trochanter minor. 7, External, 8, Internal condyle.

27.

Posterior view of same bone as fig. 26.

Fig. 28.



Front view of bones of lower leg. 1, Shaft of tibia. 9, Shaft of fibula. 2, Inner, 3, Outer tuberosity. 7, Lower extremity. 8, Internal maleolus of tibia. 10, Upper part. 11, External maleolus of fibula.

Fig. 29.

Upper surface of bones of the foot. 1, 2, Astragulus. 3, Calcis. 4, Scaphoid (boat-shaped). 5, 6, 7, Internal, middle, and external cuneiform (wedge) bones. 8, Cuboid (cube). 9, Metatarsal (added to the ankle). 10, 12, First, 11, 13, Second, 14, Third rows of phalanges (platoons.

Fig. 30.

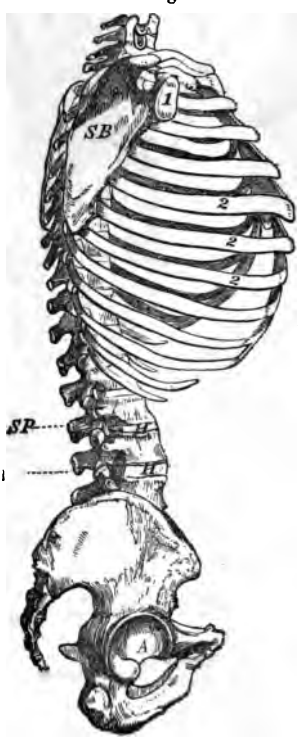
Under surface of bones of foot. 1, 2, Calcis. 4, Astragalus. 5, 6, Scaphoid. 8, 8, 9, Cuneiform. 10, 11, Cuboid, 12, 12, Metatarsal. 13, 14, 15, 16, phalanges.

Femores,	2			
Tibiæ,	2			
Fibulæ,	2	Leg bones	8	Lower extremities, 60 bones.
Patellæ (knee-pan),	2			
Tarsal,	14			
Metatarsal,	10			
Phalanges,	28			

Fig. 31.

Os hyoides (U-shaped). 1, Anterior convex portion. 2, Cornu major (greater horn). 3, Cornu minor (lesser horn). This bone is situated at the base of the tongue, and just above the top of the windpipe.

Fig. 32.



Lateral view of spinal column. Scapula. Clavicle. Chest. Hip-bone. Lower portion of sacrum, and of coccyx. SB, Scapula. 1, Glenoid cavity. 2, 2, 2, Ribs. SP, Spinous process. H, H, Intervertebral substance. A, Acetabulum.

Fig. 33.

Posterior surface of left scapula, (shoulder-blade). 10, Spine (ridge). 1, Supra (above) spinous fossa (hollow). 2, Infra (below) spinous fossa. 6, Head, upon which is a slight socket excavated, and called glenoid cavity. 8, Neck. 12, Acromion process. (The top of the shoulder and shield to the joint).

Fig. 34.

Front view of the right humerus (upper arm bone). 1, Shaft. 2, Head (adapted to the glenoid 6, fig. 33). 3, Anatomical neck. 4, Greater, 5, lesser tuberosity. 13, External, 14, internal condyle. 17, Fossa (to receive 5, fig. 35).

Fig. 35.

Front view of bones of lower arm. 1, Shaft of ulna. 2, Greater, 3, lesser sigmoid (S-shaped) notch. (The surface 2, is applied to 12, fig. 34.) 4, Olecranon process, (point of elbow). 5, Coronoid process. 10, Shaft of Radius. 11, Head. 12, Neck. 13, Tuberosity. 15, Inferior head. 16, 9, Styloid processes.

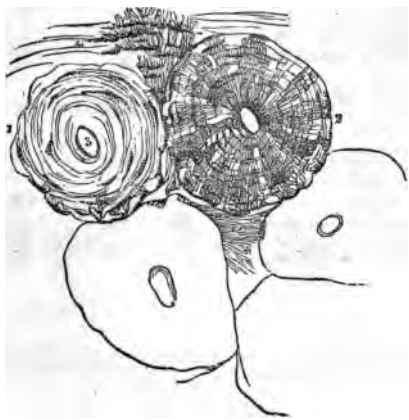
Fig. 36.

Dorsal surface of right carpus (wrist). R, Radius. U, Ulna. S, Scaphoid. L, Semi-lunar (half-moon shaped). C, Cuneiform. P, Pisiform (pea-shaped). T, Trapezium. Tr, Trapezoid. M, Magnum. U, Uneiform (hooked). 1, 2, 3, 4, 1, Metacarpal bones.

Fig. 37.

Palmar (palm) surface of the left hand. 1, Scaphoid. 2, Semi-lunar. 3, Cuneiform. 4, Pisiform. 5, Trapezium. 7, Trapezoid. 8, Magnum. 9, Uneiform. 10, Metacarpal bones. 11, 12, First; 12, 15, Second; 13, Third rows of phalanges.

Fig. 88.



Besides the bones exhibited, there are belonging to the upper extremities, two clavicles (collar-bones). Sometimes at the joints of the hand and the foot small bones are found, called from their shape, sesamoid. They are in form like the kneepan, and serve a similar purpose.

Scapulæ,	2				
Clavicles,	2				
Humeri,	2	Arm bones,	10		
Radii,	2				
Ulnæ,	2				
Carpal bones,	16			Upper extremities,	64
Meta-carpal,	10				
Phalanges,	28				

In the entire body there are 345 bones. Or if the coccyges be considered as one, which is usual, there are 340—to wit,

Cranium,	8			
Bones of ears,	6	Head,	62	Bones of Skeleton, 240.
Facial bones,	14			
Teeth,	32			
Cervical vertebræ,	7	Neck,	8	
Hyoid,	1			
Dorsal vertebræ,	12	Chest,	87	
Costæ,	24			
Sternum,	1			
Lumbar Vertebræ,	5	Loins,	5	
Sacrum,	1	Pelvis,	4	
Coccyges,	1			
Ossa Innominata,	2			
Lower extremities,			60	
Upper extremities,			64	

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M DCCC LI.

DESCRIPTION OF PLATE I.

The skeleton of the human system is a frame-work composed of three classes of organs. 1st. Bones. 2d. Cartilages. 3d. Ligaments.

The bones are the most solid parts of the body. They are composed of two kinds of substance. 1st. The animal, flexible, cartilaginous, or cement part. 2d. The earthy, mineral, calcareous, or marble part. The proportions of these vary in different bones at the same period of life, and very much at different periods of life, in accordance with the best good of the individual.

The cartilages are what are usually called the gristle, and may be arranged in four classes. 1st. Those which form the frame of the ear, and terminate the nose. 2d. Those which cover the bones at the joints—these are quite firm. 3d. Those which connect the bony portions of the ribs with the breast bone. The elasticity of these is very great and useful. 4th. Those which are placed between the bodies of the vertebræ. They are exceedingly useful, and for the most are productive of the motions of the back, support it erect, or, by yielding, cause deformity.

The ligaments are of two kinds. 1st. White, or rather pearl-colored. Those are very strong, and serve to strongly bind different parts in their place. They are so arranged about the joints as to allow the proper motions, but to restrain all improper ones. They are sometimes and usually in the form of straps, sometimes in the form of cords, and sometimes like a cap they entirely surround a joint. 2d. Yellow ligaments are somewhat elastic, and yield somewhat to great force, and thus allow motion.

Fig. 1.

Head.—8, frontal bone; *a*, perpendicular, *b*, orbital portions of it; 10, parietal bone; 15, malar; C, zygomatic process of temporal bone; *a a*, squamous, *b*, mastoid portions of temporal bone; 13, nasal; 14, lachrymal; 12, superior maxillary; 11, inferior maxillary; *a*, the central line, *b*, ramus.

Right Side of Neck.—1, cervical vertebræ; *a b*, position of the intervertebral cartilage.

Right Side of Chest.—From 5 to 5, 12 ribs may be counted; *a a a*, back portion of ribs; *b*, connection of the last true rib with the sternum; *c c*, connection of the cartilage with the false ribs; *d d*, floating ribs; *e e*, angle posterior of the ribs.

4, The sternum; *a b*, the two portions into which it may be considered as divided; *d*, ensiform cartilage.

Upper Extremities of the Right Side.—19, clavicle; 20, scapula; *a a*, internal face of scapula; *b*, anterior border; *c*, glenoid cavity; *d*, coracoid process; *e*, acromion process.

21, *Humerus.*—*a*, bicipital groove; *b*, insertion of deltoid muscle; *f*, head; *g*, anatomical neck; *h*, greater, *i*, lesser tuberosity; *k*, surgical neck; *l*, trochlea; *m p*, external condyle; *o*, internal condyle; *n*, anterior fossa.

22, *Ulna.*—*a*, groove; *b c*, internal and external angle of the radius; *d*, coronoid process; *f*, anterior superior angle; *g*, head inferior; *h*, styloid process.

23, *Radius.*—*a*, insertion of biceps muscle; *d*, head; *f*, styloid process.

Carpus.—24, scaphoid; 25, semilunar; 26, pyramidal, cuneiform; 27, pisiform: 28, trapezium; 29, trapezoid; 30, magnum; 31, unciform.

Metacarpal.—From 32 to 32.

Phalanges.—33, 34, 35, 1st, 2d, and 3d rows.

Pelvis.—A, ileum; B, body of pubis; C, descending branch of pubis; D, ischium; E, ascending branch of ischium; F, ischiatic foramen; *b*, crest of the ileum; *c*, anterior superior spinous process; *d*, anterior inferior spinous process; *e*, internal iliac fossa; *l*, ischiatic tuberosity.

36, *Femur.*—*a a*, body; *b*, external, c, internal angles; *d*, head; *f*, trochanter major; *g*, tubercle; *i*, trochanter minor; *k m*, external, *l n*, internal condyle.

37, *Patella. Rotulla.*

38, *Tibia.*—*a*, crest; *c*, internal plane; *d*, external plane; *e*, external, *f*, internal condyles; *g*, spine of the tibia; *k*, anterior tuberosity; *l*, articular surface; *m*, internal maleolus.

39, *Fibula.*—*a*, external face; *b*, internal face; *d*, head; *e* external maleolus, fig, 5; 40, astragulus; 41, calcis; 43, scaphoid; 42, cuboid; 44, 45, 46, cuneiform; 47, metatarsal; 48, 49, 50, phalanges.

Left Side Ligaments of the Spinal Column.—1, to 1, common anterior vertebral ligament; 2 to 2, intervertebral cartilage; 3 3, fig. 1 and 2, radiated ligaments; 4 4, sacral ligament; 5, sacro-coxcygian anterior.

Fig. 3.—Occipito atloidean; 7, odontoidean; 8, cruciform.

Ligaments of Thorax.—12, Inferior transverse costalis; 13 13, radiated chondro-sternal anterior; 14, vertical; 15, chondro costales.

Ligaments of Pelvis.—17, ilio-lumber: 18, ilio-vertebral; 19, sacro-iliac anterior; 20, symphysis pubis; 21, anterior pubic ligament; 22, superior pubic ligament; 23, inferior pubic ligament; 24, sub-pubic membrane.

Ligaments of Shoulder.—25, orbicular; 26, interclavicular; 27, costoclavicular: 28, capsular; 29, coraco-clavicular; 30, acromio-coracoidean; 31 31, fibrous capsule; 32, tendon of biceps; 33, tendon of sub-scapular.

Ligaments of the Elbow.—35, anterior; 36, external lateral ligament; 37, annular ligament of the radius—fig. 4; 38, anterior.

Ligaments of the Hand.—39, rhomboidal; 40, external lateral; 41, palmar ligaments; 42, transverse; 43, pisi-metacarpal; 43, capsular; 44 44, transverse palmar; 45, glenoid; 46 46, external and internal; 47, *transverse metacarpal.*

Ligaments of Lower Extremities—49, capsular; 50 50, tendon connected with rotulla; 51, 52, internal and external ligaments; 53, tendon of the aponeurosis of the fascia lata; 54, lateral external posterior; 56, bursa; 57, peroneo-tibial superior; 58 58, inter-osseous; 59, triangularis; 60, tibio-tarsal; 61, internal lateral.

Large Blood-vessels.—A, humeral artery; B, vein: *a*, point of compressing the artery against the first rib; C, radial artery; D, femoral artery; E, vein; F, anterior tibial artery.

Fig. 10 represents two vertebrae in the natural position. The true form of the bones and the articulating processes are not given. The intention is to show that they are joined so that the weight of the bone will incline it forward as in fig. 12, or it may be by sufficient force bent backward as

in fig. 11. The bones are supported in their place by intervening cartilages as shown by fig. 8. It must be compressed when the bones incline forward as shown by fig. 7. It must be spread or stretched when the bones are bent backward as in fig. 9. Thus the healthy or elastic cartilages tend to lift up the stooping person and to draw him erect when bent backward and both when bent to either side.

Fig. 15 represents the erect back.

Fig. 13. The back bent backward to the greatest degree.

Fig. 14. The back bent forward to the greatest degree.

Fig. 16, represents the usual deformity seen among females.

It is produced by the thinness of the cartilages of the chest. This is caused by a too constant pressure. For this there are four causes: 1st. Too tight clothing. 2nd. Supports in the clothing. 3rd. Supporting the clothing on the region of the waist. 4th. Not taking enough outdoor exercise. How to correct the evil is evident.

DESCRIPTION OF PLATE II.

MUSCLES.

Muscles are what is usually called the lean meat. In different animals, and in different parts of the same animals, they differ in color, and quit as much in form and size. They are composed of what are called the muscular and tendinous portion. In man, the muscular or fleshy portion is chiefly of a red color. The size and form of it vary exceedingly. It is composed of minute threads, or filaments, each of which is composed of a sheath, and substance filling it. Many such threads being gathered in a bundle, and loosely bound together by interwoven cellular substance, and encased with a sheath, form what is called a fasciculus. Many such, loosely connected by cellular substance, and encased in a sheath, constitute a muscle; the size of which is therefore governed by the number and size of the threads composing it, while its form is determined by the direction of its fasciculi. The red stripes on the figures are designed to show the direction of the fasciculi The tendinous portion of the muscle seems to be composed of the extended sheaths of the muscle and its components. They are of a pearl color, differing much in form, sometimes being gathered into a round bundle, sometimes spread out. or flattened, and covering much space, when they are called aponeuroses. They also differ much in size and length, sometimes hardly of such length as to be seen, sometimes they are many inches long. Their composition is often very peculiar, and curious. They may be merely gathered into a bundle, and, as it were, compacted. Again we find them, as it were, braided in the most ingenious manner, to gain strength. The use of the muscle is to produce motion. This it does by contracting. The influence which causes its contraction is called nervous influence, and usually produced by the action of the mind upon the brain, from which, through nerves, the influence is exerted. That the muscles may fulfil their duties with facility, therefore, the state of the mind must be right. The effect of properly contracting the muscles is not only to produce the desired motions, but also by means of nerves and the brain, pleasant sensations; and, in addition, the health of the muscle and all other parts of the body is increased. Too little or too great exercise of the muscles produces unpleasant sensations, and injures the health of the muscle, and all other parts of the body.

The muscles of the body may be divided into voluntary and involuntary, and mixed.

The voluntary muscles, as they are called, can be brought into action involuntarily. This shows that nervous influence can be produced with-

out the agency of the mind. The mixed are those which we can voluntarily control for a certain length of time. The muscles may also be divided into Flexors and Extensors. The voluntary muscles may again be divided into—1st, Those of the back, and which, by their action, tend to preserve the body erect. 2d, Those of respiration. 3d, Those which modulate the expired air, and produce voice. 4th, Those of the face, and which produce facial expression. 5th, Those of the eye. 6th, Those of gesture. It is to be observed of all these, except those of the eye, at least, that their action, when voluntary, is not only produced by the intellectual, but also by emotional states of the mind. Those of the eye are nearly, if not quite, dependent upon the state of the emotions.

Head.—25, Frontalis; 24, Orbicularis Palpebrarum, (circular of the eyelids); 26, Occipital, (back); 27, Orbicularis Oris, (circular of the mouth); 28, Compressor nasi, (nose). 29, Levator labii superioris alaeque nasi, (levator of upper lip and wing of the nose) · 30, Zygomatic Major, (yoke greater); 31, Buccinator, (trumpeter); 32, Depressor Anguli Oris, (depressor of the angle of the mouth); 33, Depressor labii inferioris, (depressor of the lower lip); 34, Levator labii inferioris, (levator of lower lip); 35, Masseter, (to chew); 36, Fig. 6, Temporalis, (belonging to the temple) Fig. 7, 37, Pterygoideus internal; 38, Pterygoid external.

Neck.—66, Attachments of Sterno-Cleido-Mastoideus, (breast-bone collar-bone mastoid process); 7, Trapesius, (only a very small portion of it is seen); 8, Omohyoideus, (Shoulder hyoid, u-shaped bone); 9, Sternohyoideus, (Sternum hyoid); 10, Sterno-thyroideus, (Sternum thyroid cartilage); 11, Longus-colli, (long of the neck); 12, Recticus-anticus-major, (straight-anterior-greater); 13, Scalenus-anterior, (triangular); Scalenus-posterior; 15, Levator anguli-scapulæ, (levator of the angle of the scapula, (shoulder blade); 16, Splenius; 17, Digastricus,'(two-bellied); 18, Stylo-hyoideus; 19, Fig. 5, Milo-hyoideus, (molar ridge of lower jaw and hyoid bone); 20, Genio-hyoideus, (climhyoid); 21, Fig. 4, Thyro-hyoideus; 22, Crico-thyroideus.

Chest and Abdomen.—1, Serratus-magnus, (saw-toothed great); 2, Attachment to the clavicle of a portion of pectoralis major (greater of the chest); 3, Intercostales, (between ribs); 4, Fig. 3, Triangularis sterni, (triangular of the breast bone); 5, Transversalis abdominis, (transverse of the abdomen.)

Upper Extremity.—39, Deltoid, (like Greek D); 40, Biceps Brachialis, (two-headed); 41, Coraco-brachialis, (coracoid process and arm); 42, Brachialis anticus, (arm anterior); 43, Triceps-extensor cubiter, (three-headed extensor of the lower arm); 44, Pronator radii teres, (round pronator of the radius); 45, Flexor-carpi-radialis, (radial flexor of the wrist); 46, Palmaus-longus, (long muscle of the palm); 47, Flexor-carpi-ulnaris,

(ulnar flexor of the wrist); 49, Supinator-longus, (long supinator); 50, Extensor-carpi-radialis-longior, (the longer extensor of the wrist.) 51, Extensor-carpi-radialis-brevior, (shorter radial extensor of the wrist); 52, Extensor communis-digitorum, (common extensor of the fingers); 53, Extensor minimi digiti, (extensor of the smallest finger); 54, Extensor, carpi ulnaris; 55, Anconeus; 56, Abductor pollicis, (to draw away the thumb); 57, Extensor brevis pollicis.

Lower Extremities.—61, Gracilis; 62, Sartorius, (tailors); 63, Rectus, (straight); 64, Vastus internus, (vast internal); 65, Semi-membranosus, (half membranous); 66, Adductor magnus; 67, Portion of Iliacus internus, (internal iliac). 68, Aponeurotic-fascia-lata, (portion of the broad fascia, (sheath,) like an aponeurosis): 69, Tensor vaginæ femoris, (tensor of the sheath of the leg); 70, Gluteus maximus; 71, Gluteus medius; 72, Superior extremity of the pectineus; 73, Superior extremity of adductor medius; 74, Vastus externus, (vast external); 75, Biceps femoral, (two-headed of the leg); 76, Gastrocenemius, (belly of the leg); 77, Flexor longus digitorum pedis, (long flexor of the toes); 78, Tendon of long flexor of the great toe; 79, Tendon of tibialis postieus; 80, Tibialis anticus, (anterior tibial); 81, Extensor longus digitorum pedis, (long extensor of the toes); 82, Peroneus tertius; 83, Peroneus longus; 84, Peroneus brevis; 85, Annular ligament; 86, Abductor pollicis pedis, (abductor of the great toe); 87, Abductor minimi digiti pedis, (abductor of the smallest toe); 88, Extensor brevis digitorum pedis, (short extensor of the toes.)

DESCRIPTION OF PLATE III.

NERVES—POSTERIOR VIEW.

PROLEGOMENA.

The nervous system may be considered under two heads. 1st, Nervous centres. 2d. Nerves, or means of communication. The nervous centres may be considered in two aspects:—1st, They are parts upon which influences are exerted from the different parts of the body. 2d, From the nervous centres influences are exerted upon the various parts of the body. The influences exerted upon the nervous centres are various. Those exerted for the centres may either tend to produce motion, by causing the muscles to contract, or they may be of such a character as to control the action of any organ. The nerves are of two kinds, and perhaps three. 1st. The sensory nerves are those channels or means of communication through which influences are exerted from the various parts of the body upon the nervous centres. 2d. The motory nerves are those means by which certain influences are exerted from the centres upon various parts of the system. 3d. A third kind of nerves are by most thought to exist. Through these it is supposed that influences controlling the organic duties of the various parts of the body are exerted. The nervous centres are to be distinguished as at least threefold, and, still better, fourfold. 1st. The Large Brain, (cerebrum.) 2d. The Small Brain, (cerebellum.) 3d. The Spinal Cord. 4th. The Sympathetic (ganglionic, organic, etc.) nervous centres. The large brain is thought to be composed in part of quite a number of different centres, the duties of each being thought somewhat peculiar. In the different parts of the spinal cord it is also thought by some that different nervous centres should be distinguished, the duties of each being sui generis. The sympathetic is also supposed to be a multiple. Of it more will be said in connection with the appropriate plate. The Nervous Centres are composed of two kinds of substance. 1st. The Grey Substance is a cream-colored, very pulpy substance. It is found at the outside of the cerebrum, and, to a greater or less degree composes several of the lower and inside parts of the brain. It is found in alternate layers in the cerebellum, and in the inside of the spinal cord. It is also found in certain parts called ganglia, supposed to be centres of some

character. 2d. The White Substance is, for the most part, of a fibrous character. The greater portion of the inside of the cerebrum is composed of it. It alternates with the grey substance in the cerebellum. It is found at the outside of the spinal cord, of which it forms a large part. Nearly all the nerves are white fibres. Some are, however, grey. Outside the back bone the nerves do not appear to be of more than one kind. Inside the back bone they are observed to have what are called two roots, by one of which it connects with the back portion of the spinal cord, by the other with the front portion. The back root is found to be the sensory, the front root the motory. Some of the nerves which connect with the centres through the skull are of but one kind. How the nerves commence or terminate in any part of the body is not known. Some are thought to commence, and others to terminate, in each of the nervous centres mentioned. The nerves are merely conductors of nervous influences, so far as we can judge. A nervous plexus is where several nerves interchange fibres with each other, thus forming a kind of net-work.

DESCRIPTION OF PLATE.

Head.—E, Posterior lobe of the cerebrum. F, Cerebellum. K, Facial nerve.

Neck.—In the region of the neck eight pairs of nerves, called cervical nerves, arise from the spinal cord, A, A, and pass out through each side of the spinal column.

Back.—Twelve dorsal nerves (from B to B) pass from the spinal cord. Five Lumbar (from C to C) and five Sacral, (from D to D.)

Arm.—G, Axillary, or circumflex; 32, cutaneous of the shoulder; 33, nerve of latissimus dorsi; 34, nerve of teres major. H, Radial nerve; 35, internal cutaneous branch of radial; 36, long external branch for the triceps; 37, long internal branch for the triceps; 38, external cutaneous radial branch; 39, branch for the anconeus; 40, terminal external branch of radial nerve; 41, superficial cutaneous or digital branch; 42, internal collateral dorsal; 43, median dorsal; 44, internal median. I, Cubital, or ulnar; 46, dorsal cutaneous branch; 47, internal dorsal ulnar; 48, internal digital; 49, external collateral dorsal; 51, cutaneous palmar branch. K, Median nerve.

Lower Extremity.—L, External muscular branch of sacro-lumbar

nerves; 58, internal branch; 59, external branches of crural. M, Sciatic major; 60, semi-tendinous; 61, biceps; 62, semi-membranosus; 63, adductor; 64, biceps minor. O, External popliteal, or peroneal; 65, peroneal saphena; 66, musculo-cutaneous, or external peroneal. P, Internal popliteal, or posterior tibial; 67, plantar. Q, Posterior saphena, or external tibial. The figures that follow refer to branches of the above, as will readily be seen.

DESCRIPTION OF PLATE IV.

The object of this plate is to show the manner in which seeing takes place.

Fig. 7. W, W, represents the light of the sun streaming through a small hole into a dark room. P, represents a prism placed in the course of the light. In passing through the prism the light is represented as bent, or refracted, at the surface of entrance and exit. By this means we ascertain that sunlight is made up of three kinds—for they are not equally refracted, but as represented; the blue light the most, the red the least, the yellow intermediate. The light is represented as passing to eight nerves, very much magnified. On the lower one the red light acts by itself, and a sensation of redness results; on the third one the yellow acts, and a decided sensation of yellow is caused; on the second one both the yellow and red light act, and the sensation of orange is perceived; on the fourth and fifth the yellow and blue light act, and a sensation of green is produced. The precise state of the case could not be represented. In truth, some little of the red is refracted as far as to the top nerve; while again some of the blue is not refracted above the first nerve. Thus all the varied and beautiful shades of the prism, or the world-admired rainbow, are produced by the three simple colors; and when they all act in succession upon the nerves a most pleasing effect is caused.

Fig. 8, represents the three natural colors, and by means of the triangles and diameters the combinations of colors, which are natural, and which will be pleasing, can be seen. The ratio of surface of the colors is not correctly represented, but should be in the proportion of three red, five yellow, and eight blue, in all sixteen, which may be said to be white, while O is black. At the angles of one triangle are seen the colors R, Y, B. These are the same as those of the added angles of the other triangle, viz., O — R and Y: G — Y and B. P — R and B. At the opposite extremities of any diameter the harmonizing colors are also formed; for instance: R at one extremity, at the other B and Y — G: viz., Red and Green always good in contrast. Purple, — Blue and Red at one extremity, Yellow at the other.

Fig. B, represents the three kinds of light falling upon an object which does not reflect either; it is therefore a black object: for if we go into a perfectly dark room, where no light acts upon the nerves of our eyes, a sensation of blackness is experienced: therefore, when we look toward an object, and have a sensation of blackness, it must be, as in this figure, because no light comes from it.

Fig. W, represents three kinds of light falling upon an object which reflects all three. It is, therefore, perfectly white, or a perfect reflector of all kinds of light; for if one alone falls upon it it reflects that. In the case of this fig. it is seen that the eye receives the same kinds of light, and in the same relations, as it might before the light had been reflected, if the eye were placed where the reflector is, and directed the right way. What we ordinarily call white objects do not reflect the three kinds thus perfectly as a mirror does, there is more or less of some kinds not reflected—hence the peculiar color.

Fig. R, represents the red light only, as reflected.

Fig. Y, represents the yellow light reflected.

Fig. B, represents the blue light reflected.

Fig. P, represents two kinds reflected.

Figs. 5 and 6. These are intended to show what is or should be meant by an optical

object, in distinction from a mental one. In fig. 5, A and B are, in fact, distinct, but they will not appear so, that is, they will be considered by the person seeing them as one optical object; because they are so near together that the light passing from them acts on one single nerve, *b*, as seen. But in fig. 6. A B become distinct to the eye, because so far apart that the light passing from them to the eye acts on two different nerves, and they will, of course, seem to be, as they are, some distance apart. If, by means of a microscope used in connection with fig. 5, we could cause the light from A to act on the nerve *a*, we should then see, as in fig. 6, two objects, and not one purple one. The two would seem also as large, or as far apart, the same thing, as in case of fig. 6.

Fig. 1. Before this eye there are three candles, B, Y, R. We wish to know their color and their direction. Their direction we shall partly be able to learn by their color; by knowing their color we shall be pleased, because, with few exceptions, man has been so constituted as to be pleased with colors If all the nerves 3, 3, were exposed to the action of the light from all the candles, we should not be recipients of the pleasure arising from sensations caused by a successive action of colors, nor could we learn the directions of objects. Therefore the sides of the eye are walled in by the white coat 2, and closed in front by a transparent part, the cornea *a*. (A particular description of the anatomy of the eye will be given on another plate.) A short distance from the cornea, a curtain, the iris, with an opening, the pupil, is placed. It is now seen, as light passes in straight lines till refracted, that the light from one candle cannot, in their present positions, fall on the same nerves as the light from either of the others. But some difficulties remain. The light acts over so many nerves that a dim effect would be produced at the same time that but few objects could be viewed and seen distinctly; nor do I know how the precise direction of an object could be learned; hence—

Fig. 2 is needed to correct the evil. Here 1 represents the crystalline lens, as if it chiefly refracted the light. It does not, however; it is chiefly done, of course, by the cornea. It matters not just now. It is seen that the light of each candle reaches a nerve distinct from the light from the other candles; for though mingled with them before it enters the eye, and in a portion of the eye, it is not so when it reaches its focus, which is at the nerve exactly; thus each color may be appreciated, provided the objects from which the light comes are so far apart that the light falls upon different nerves. We can, of course, see a multitude of objects, as many, viz., as we have nerves; and, of course, we may be so constituted as to know precisely the direction from whence any light has come to the eye; for, as in the healthy eye, if a nerve be acted upon, there is only one direction in which the light can have come to the eye, we could be so made as to believe the object was in the direction from which the light must have come; and thus we do. (It may be here said, that the precise manner in which the nerves commence in the back part of the eye is not known; but they are represented by the black *points*, though they are, in fact, white, as if that were their mode of commencement.)

Fig. 3. represents the long-sighted eye. Here the light is not refracted to a focus before it reaches the nerves; hence the red acts over the nerve from 4 to 6; the yellow, from 5 to 7; the blue, from 6 to 8. (The yellow is not very apparent beneath the red, it is so much covered by the red.) There are, therefore, here represented the causes of four sensations. Red is caused by the light acting from 4 to 5; orange, by the red and yellow acting from 5 to 6; green, by the yellow and blue acting from

6 to 7; and blue by the light acting from 7 to 8. (There would be, in fact, many shades of color, and, of course, as many sensations.) There being four sensations, the person would have the idea there were 4 objects where there were but 3; and no idea that either of the 4 were yellow; nor do I know how he could know the precise direction of either object, as shown by:

Fig. 9 represents the long-sighted eye with only one object before it. The light from A acts on the nerves from *b* to *c*. As before shown, we are so constituted as to believe, when the nerve *a* is acted upon, the light comes from the direction A *a*, which is the fact; but from the same reason, the nerve *c* being acted upon, we shall believe the light has come from the direction B *c*, so also from C *b*. Hence the object will seem to occupy all the space from B to C. We have often seen an old lady try to thread her needle as if the eye of it occupied a large space.

Fig. 4 represents the short-sighted eye. In this case it is seen that the light is refracted so as to produce a focus before it reaches the nerve. As light passes in straight lines till by some cause it is refracted, of course the rays of light cross each other and by the time they reach the nerves the red light acts from 5 to 6, &c.; as in the equally bad long-sighted eye (fig. 3,) the results being the same in both cases, as is also seen by

Fig. 10 represents the short-sighted eye. In this, as in the long-sighted, the nerves, from *b* to *c* being acted upon, the object seems to occupy all the space from B to C.

Fig. 11 represents the reflection of light from the back part of eye 1, and seen by eye 2, through the orifice *o*, made in the lower and under part of the eye. Eye 2 would speak of seeing the image in eye 1. It is only, however, eye 2 that is cognizant of it. Here also is seen the reason for this image, as it is called, being inverted to eye 2. The upper light from the visual object *u* comes from a part of the top of the trees, and acts upon the nerve *a*, on which account eye 1 believes the object *u* to be in the line *a u*, as is the fact; and, of course, it appears to come from above the lower object L, the light from which acts on nerve I, and, of course, seems to come from direction L 1, and from below the upper object *u*. Now, neither of these objects can be inverted; for blot out one, and in respect to the other, what is there to invert? But to the eye 2. The light from either I or *a* will seem inverted since the light from I seems to come, as it does, from the direction I 2, which is, of course, as it were, from up in the air, and the roots of the tree will seem to be in the air. It will also seem to come from above the light *a* 2, which is quite the reverse of what seemed to eye 1. If the space between U and L be filled by the parts of a tree it will make no difference, the principle is the same, the mental object, a tree, being composed of a great number of visual objects.

PLATE V —BLOODVESSELS—VASCULAR SYSTEM—PROLEGOMENA.

The vascular or circulatory system may well be so called, as it is composed of sets of tubes, and a forcing apparatus by which the blood is caused to pass through an unceasing round.

The blood-vessels are of three kinds, of each of which there are very many. 1st. *The capillaries* are a set of tubes, the apparent color of which is given by their contents. These being sometimes the bright red, and sometimes the dark red or purple blood, and sometimes a mixture varying in its proportions, the color varies. They are smaller than hairs, opening into each other, and arranged like a net-work. They are so near each other that sometimes the meshes are smaller than the diameter of the vessel. In form, arrangement, and some other apparent respects, the capillaries of different parts differ. The most important difference is to be noticed in the results which take place in the fluids passing through them. Upon what in particular these depend is not known. The capillaries exist in or exceedingly near to every, even the smallest part of the body. They are almost infinite in number. They are of use, as some think, in propelling their contents. The changes which the blood undergoes, take place either in them or in their immediate vicinity, and wholly or in part through their action. By enlarging or diminishing, they will increase or diminish the amount of blood contained in any part, as is seen when the cheek is flushed or paled.

The veins are a set of tubes appearing blue when seen through the skin, on account of the dark or purple blood they there contain. Certain others which lead from the lungs contain bright red blood, and would appear of that color. They are exceedingly small where they commence, but frequently opening into each other, larger ones are formed, as seen on the back of the hand. They commence in the capillaries of all parts of the body, and uniting together, large ones are formed, which terminate in the heart. They may be considered as of three kinds, which are alike in all important respects, except as to where they commence, terminate, and their contents. 1st. Systemic veins. One kind commences in all parts of the body, including the lungs. All those from the lower and middle parts of the body unite to form a tube (vena cava ascendens,) which opens into the right auricle of the right heart. From the upper parts of the body a similar tube (vena cava descendens) opens into the same heart. The use of these veins is to allow the substance produced by the action of the various parts of the body to flow to the right heart. 2d. Pulmonary (lung) veins. Another set of veins commence from the capillaries existing upon or in the sides of the air-cells of the lungs, and lead to the left heart. Their use is to allow the blood which has been acted upon by air to flow to the right heart. 3. A third set of veins commence in the capillaries of the stomach (gastric.) Second stomach (mesenteric,) Pancreas (pancreatic,) and Spleen (splenic.) These veins uniting together form what is called the Portal Vein (vena porta.) It leads to the liver, in which it divides and subdivides, opening at last by very small branches into (as it is supposed) certain capillaries of the liver. The use of these veins is to allow the uncarbonized blood to flow to the liver, which requires carbon in the formation of bile, the required quantity of which depending somewhat, at least, if not wholly, on the quantity and kind of food digested, this should influence the quantity of blood received by the liver. As the digestion of

the food is in ratio to the flow of blood to the stomach, &c., of course as it now is, the quantity of blood received by the liver is in the same ratio. In those veins which are subject to pressure, what are called valves are formed. They are folds of the inner coat of the vein, arising from one side in such a manner as easily to allow the blood to flow from the capillaries. If it be pressed backward, its action against the valve throws it across the vein, which is thus closed.

The arteries are the names of tubes, through which blood flows to the capillaries. They are said to be of two kinds; 1st. Systemic arteries. These contain bright red blood, and appear, of course, the same. The largest is about an inch in diameter; it divides and subdivides, till where its branches open into the capillaries they are too small to be seen by the naked eye. In structure, the arteries are firm and elastic, so that when cut across they remain open though diminished in diameter; they are, therefore, quite different from the veins, which are flaccid, and easily compressed. They commence by a single tube from the left heart, and terminate by exquisitely small branches in the capillaries. At various places they open (anastomose) by cross and reflex branches into each other. They are of use by receiving the bood from the impulse of the left heart, and allowing (as most also think, by assisting,) the flow of blood to the capillaries. On account, therefore, of their structure and use, the large branches are buried deeply below the surface; 1st. That the blood flowing through them may not become cold before it reaches the parts it is destined to warm. 2d. That they may not be injured by a slight wound.

2d. Pulmonary arteries. These are similar to the systemic, except that they receive blood from the right heart, and, of course, like their contents, appear purple or dark red. They commence by a single tube, and terminate in the capillaries, upon the side of the air-cells in the lungs. They are of use in transmitting the blood brought to the right heart from all parts of the body, to the air to be acted upon by it.

That which is ordinarily called the heart is composed of two, called right and left. Each is composed of two parts, the upper called an auricle, the lower a ventricle. Each of these is composed of a lining, forming, as it were, a bag, of a muscular coat, very thick on the ventricle, thin in case of the auricle. The muscular fibres are fine, and so interwoven as to surround the lining, to which they closely adhere. When the fibres contract, therefore, they compress the contents of the heart, and expel them. The contractions of the sides of the auricle are of use in pouring the blood down into the ventrical, which is expanded, relaxed, or open. As soon as filled, it contracts, and pours its contents into the artery opening from it. Between the auricle and ventricle there are valves attached by one part around the opening leading from the auricle into the ventricle. These valves open into the ventricle, but the backward pressure of the blood closes them. Valves also exist at the opening from the ventricle into the artery. These open out of the heart, and close by the backward movement of the blood.

The use of the right heart is to receive the blood retured from the systemic capillaries through the systemic veins, and, by contracting, to pour it through the assisting pulmonary arteries into the pulmonary capillaries, through which it passes on into the pulmonary veins, through which it passes to the left heart. It is of use by receiving the blood returned from the air and pouring it out through the systemic arteries into the systemic capillaries, through which, with greater or less force, it moves into the systemic veins, again to return to the right heart, and thus run its unceasing round, unless used or cast from the body while passing through the capillaries of some part. The whole circulation, in its order of movement, is laid down in fig. 8, plate 5.

DESCRIPTION OF PLATE.

Head.—22, facial artery; *d*, labial inferior; *e*, labial superior; *f*, transversalis; *g* frontal branch of the ophthalmic; *h*, frontal and parietal branches of the temporal; 23, facial vein; *i*, frontal vein; *k*, angular vein; 24, temporal vein.

Neck.—13, common carotid; 15, internal jugular; 16, external jugular; 19, anterior jugular; 20, subclavian artery; 21, subclavian vein; *a*, transverse cervical vessels; *b* superior scapulary vessels.

Trunk.—1, branches of internal mammary; *a a*, external branches of same; 2, internal mammary veins; 3, epigastric artery; 4, epigastric vein; 5, 6, superior thoracic artery and vein; 9, 10, circumflex iliac artery and vein; 11, 11, 11, terminal branches of the intercostal vessels; 12, 12, terminal of lumber vessels.

Arm.—Arteries; 25, axillary; 5, acromic thoracic 7, inferior thoracic; 26, humeral or brachial; 27, radial; *a*, recurent radial; *b*, radio-palmar; *c c*, palmar-interosseous 28, ulnar; *d*, recurrent ulnar; *e*, median; *f f*, digital; 29, collateral.

Deep Veins.—30, 31, palmer; 32, ulnar; 33, radial; 34, humeral, brachial; 35 median cephalic; 36, cephalic; 37, basilic; 38, axillary.

Leg.—Arteries; 39, femoral; *a*, inguino abdominal; *b*, pudic; *c*, profunda; *d*, external circumflex; *e*, superior internal articular; *f f*, internal circumflex; *g g g* perforating; *h*, crural; *i*, rectus; *j*, internal muscular; *k*, superior internal articular; *l*, inferior internal articular; *m*, superior external articular; *n*, inferior external articular; 40, anterior tibial; *o*, recurrent anterior tibial; 41, dorsalis pedis; *p q*, interosseous branches; *r*, subtarsal; *s*, submetatarsal; 42, posterior tibial.

Deep Veins.—43, 43, dorsalis pedis; 44, anterior tibial; 45, femoral *t*, profunda

Superficial Veins, left side.—Arm; *a*, cephalic of the thumb; *b*, superficial radial; *c*, cephalic; *d* common radial; *e*, deep radial and ulnar; *f*, anterior ulnar; *g*, median basilic; *h*, median cephalic; *i*, basilic; *k*, cephalic; Leg; *a*, supermetatarsal; *b*, external; *c*, internal pedal; *d*, saphena internal; *e*, femoral *f*, transverse articular arch.

DESCRIPTION OF PLATE VI.

All the figures on this plate are more or less fanciful, and the parts represented more or less distorted. The object is to exhibit important ideas, which could be shown more clearly by the mode adopted than by strictly correct anatomical views.

Fig. 2. This represents the organs of the chest and abdomen, when the front walls of those parts of the body are removed. 12 represents the right and left lungs. Between them and back of H, the hearts would be found. The elements of the lungs may be counted as 8, viz.: 1st. The windpipe and its divisions, composed of four-fifths of cartilaginous rings, completed, and also attached to each other by yellow ligaments. (See T and its divisions B. fig. 5, also 1, fig. 4.) 2d. The windpipe is lined by a delicate membrane called mucous; it also forms the sides of the air-cells, which, millions in number, exist at the extremities of the windpipes, of which an idea is given at 1, 1, 1, fig. 4. The use of these two elements is to allow the free action of the air upon the blood. The air passes easily through the constantly open pipes into the air-cells, the sides of which are hardly thicker than the sides of a soap-bubble. 3d. The air being received, it is necessary the blood should be brought to it. This is accomplished as described in explanation of plate 4.

From the right heart, R H, fig. 11, the blood is driven out through P A, fig. 11 and 10, into the net-work of capillary vessels, P C, fig 10. They exist on the sides of each of the air-cells. Fig. 3 may be supposed to represent those on the sides of one cell, not as large as the smallest mustard seed. From these a set of veins lead the blood back (P v1 P v2, fig. 10 and 11,) to the left heart, L V. There are, therefore, three kinds of blood-vessels composing the third element of the lung, as seen in fig. 4, viz.: the pulmonary artery, the pulmonary capillaries, and the pulmonary veins. 4th There is a substance filling what would otherwise be space between the cells, blood-vessels, &c. It is called parenchyma, also *the substance* of the lung, by way of distinction. It seems to possess a great degree of elasticity, which it is of much importance to observe. 5th. An external covering of the lung will now be required. It is called the pleura pulmonalis, and represented by P, P, figs. 5, 6, 4, 7. It is very thin and delicate. 6th. Another class of blood-vessels will also be required to answer the wants of all parts of the lung. Those previously mentioned have reference merely to the action of the air. The class now required are a part of what are called the systemic vessels. They are composed of three kinds; arteries, capillaries, and veins. The arteries are a branch of the systemic arteries; and the blood is derived, through them, from the left heart. The veins lead back to the right heart. They are not represented on this plate. The capillaries of this set exist in all parts of the lung. 7th. Nerves are also required, and of two kinds; one through which influences act upon the lungs; another through which influences act from the lungs. 8th. In addition to the parts mentioned, lymphatics and some other parts are found.

The lungs being thus formed, we have next to inquire how the air is caused to pass in and out of them. Suppose that we call for illustration the contractile power of the

lung 10. This power may depend upon the parenchyma in part or wholly, or in part or wholly upon the supposed existence of muscular substance in the sides of the windpipe. This power acts constantly to press the air out of the lung. It cannot be filled, therefore, till 10 is overcome. Two things are now to be noticed: if the lung be taken from the chest, and the windpipe left open, 1st. The air presses upon the surface of the lung. Let this power be repressed by 15. This, of course, acts with the contractile power 10. The total power expelling the air is 25. 2d. The air, of course, presses with the same force into the lung as upon the outside, viz., 15. This is, of course, less than 25 by 10. If the external pressure (15) of the air could be taken from the 25, only 10 would be left to resist the inward pressure 15, which would overcome and fill out the lung. If, then, the 15 could again be added to 10, making 25, the internal force would be balanced by the external, and the 10 contractile power left to expel the air. All that is necessary, therefore, is to place the lungs in such a position that the external pressure of the air can be taken from the lung, and again allowed to act, and the air must alternately pass in and out of the lung. Plate 1 shows the frame-work of the chest; 12 vertebrae behind, the same number of ribs upon each side, the breast bone in front. Between the vertebrae intervertebral substances are found, very elastic, as are the cartilages, which in front connect the ribs with the breast bone. The connection of the ribs, and the elasticity of the cartilages mentioned, are such that if the ribs are drawn down the diameter of the chest is lessened; the cartilages of the back are compressed, and those of the ribs spring from their natural position and shape. Hence, as soon as the force which has lowered the ribs is removed, the cartilages of the back and ribs tend to raise them. When the cartilages of the back were compressed, the spinal column was curved forward. The efforts of the muscles of the back to straighten it will, of course, tend to raise the ribs; and their farther action will elevate them above the natural point, and, of course, increase the diameter of the chest. The ribs are also raised by other muscles as well. The cartilages of the back are thus spread open, so to speak, and those of the ribs raised from their natural position. When the force elevating the chest is removed, the action of its cartilages would at once tend to diminish it. This frame-work is formed into air-tight boxes, one upon each side, by lining it and closing the bottom and top by the same kind of skin or membrane as covers the lungs. It is called pleura costalis, and is seen at P C, figs. 4, 5, 6, 7. It is continuous with the covering of the lungs, as seen in figs. 5 and 7. In these boxes the lungs are placed. As they have communication with the air by means of the windpipe, they are at once filled to the size of the box, and increase or diminish with the size of it, as shown by fig. 4, where on one side the diameter and perpendicular height of the box has been increased. In this figure the diaphragm D is represented. It is composed of muscular fibres, the tendons of which are attached on the one side to the bottom of the frame-work, and at the other extremity of the fibres form the part seen at 4, fig. 1. The pillars of the diaphragm are seen attached to the spinal column. It is also seen in its natural arched position between the organs of the chest and the abdomen. It is also seen at 3, fig. 2. When the muscular sides of this contracts, the upper portions of it upon each side, or what are called its arches, must be depressed. At the same time, the ribs are raised, as before stated, and the air rushes into the lungs, and they are enlarged. At the time the arches are depressed the organs beneath in the abdomen, viz.: 4, the liver; 5, the stomach; 6, the colon; 7, the second stomach; 8, the spleen; 9, the gall bladder—must be pressed downward, causing a distension of the sides of the abdomen. These, as shown by fig. 1, are in part muscular. Some of

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the muscles reach across from the ribs and breast bone to the front part of the hip bone below; when they contract, they will, therefore, draw down the ribs, and also press inward and upward the organs of the abdomen. Thus on every side the walls of the chest are made to approach the lungs. The external pressure of the air is thus allowed to balance the inward, and the contractile power of the lungs expels the air. If the air passage be closed, the action of the muscles can cause much force to act on the lungs, and the air is expelled with explosive force as soon as the obstruction is removed.

In fig. 6, H, and 4 and 5 in fig. 4, represents the position of the hearts, of which there are two, the right and left, as described in description of plate 5, and as seen by fig. 11 and fig. 6. The use of the hearts is to keep the blood in motion. Its course through the body is shown by fig. 8. In S C (systemic capillaries) it is changed from bright red to dark, and in other respects; (see fig. 9;) it then moves through S V (systemic veins) into the R H (right heart,) R A (right auricle,) R V (right ventricle;) see also fig. 11.) It then passes through P A (pulmonary artery;) (see also fig. 10) into P C (pulmonary capillaries,) (see fig. 10.) Here the blood changes to bright red, and in other respects, and passes through P V (pulmonary veins) into the L H (left heart,) L A (left auricle,) L V (left ventricle;) (see also fig. 11.) The blood is then forced into and through S A (systemic arteries;) (see also fig. 9.)

Fig. 7. P C, pleura cestalis; P P, ploura pulmonalis; B, one of the vertebrae of the back; S, spinal canal; Sp, spinous process; H, place of the heart; R, ribs cut across; M, muscular substances between the ribs; sk, skin, and the divisions of the wind-pipe and blood-vessels, caused by a transverse section of the body.

Figs. 9, 10 and 11 are, as it were, but one. They are intended to represent the hearts' systemic and pulmonary circulations. P A of fig. 9 is connected with S A of fig. 11, and P V1 and P V2 of fig. 9 with the same parts of fig. 11. P A and P V1 and P V2 of fig. 10 with the same of fig. 11.